MS-116

project
mercury

OPERATION AND MAINTENANCE

ACQUISITION SYSTEM
KAUAI ISLAND, HAWAII

prepared for

National Aeronautics and Space Administration
Contract No. NAS 1-430

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The Bendix Corporation
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in association with

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WARNING

The equipment described in this manual employs voltages which are dangerous. Use appropriate caution when working on this equipment.

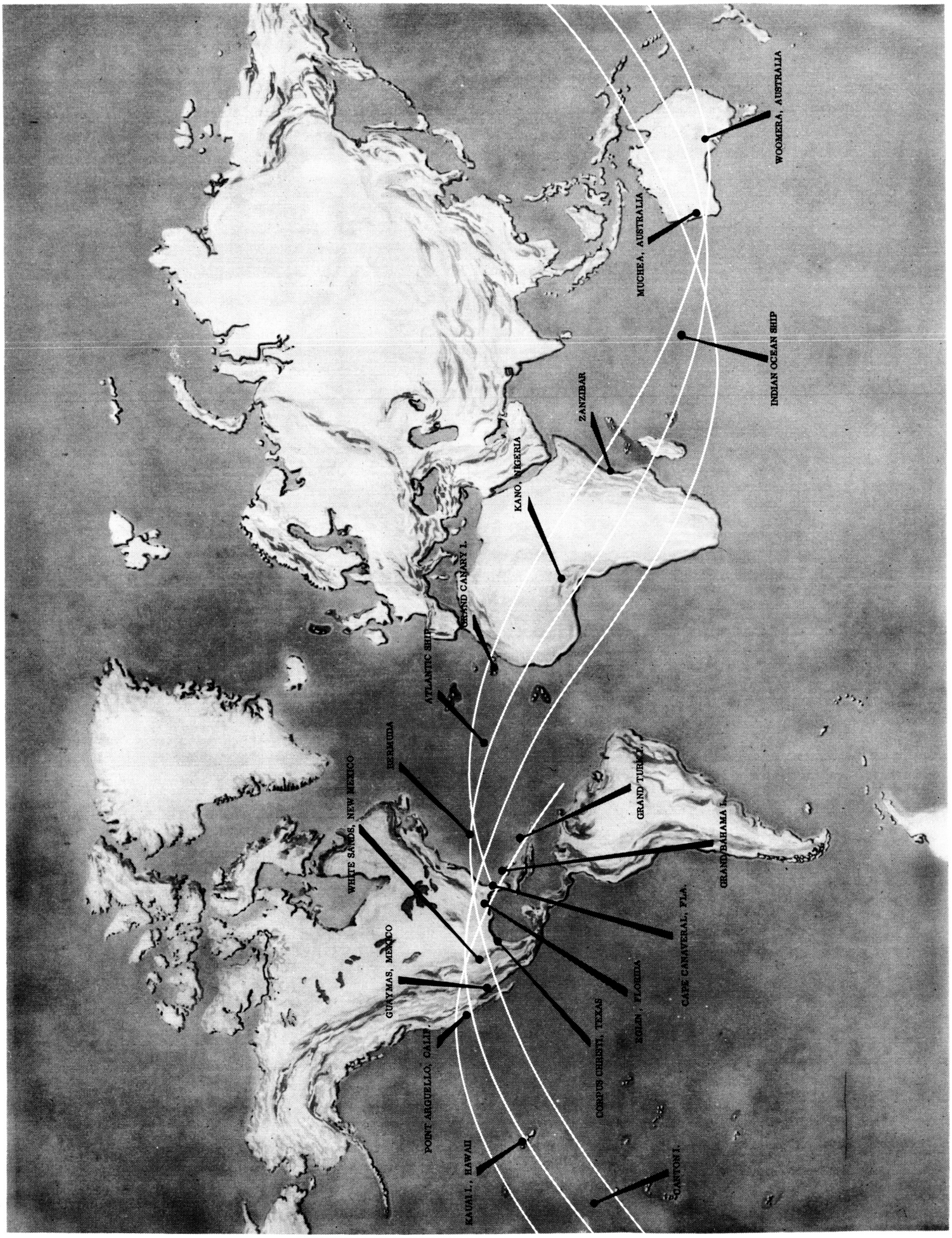


Figure 1-1. Locations of Project Mercury Sites

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL INFORMATION

A. SCOPE OF MANUAL

This publication comprises operating and maintenance instructions for the acquisition system which forms a part of the Mercury ground instrumentation at Kauai Island, Hawaii.

B. PROJECT MERCURY SCOPE

(1). The prime objective of Project Mercury is manned orbital flight with a safe return of the man from orbit. The manned vehicle or satellite that is placed into orbit is called the capsule, and the individual making the orbital flight is called the astronaut.

(2). A launch vehicle with a radio-inertial guidance system will be used to place the capsule into orbit. The launch will be from Cape Canaveral, Florida with launch azimuth slightly north of east (inclined 32.5 degrees to the equator) and nominal orbit insertion point approximately 410 nautical miles from Cape Canaveral. The planned orbit will have a period of 88 minutes and will be at an altitude of 105 ±5 nautical miles.

(3). Initially, the orbital flights will each consist of three orbital cycles with a water landing west of Puerto Rico. In the event of an in-flight emergency, backup systems are provided in the capsule to permit the flight to continue until the next passage over the eastern United States. Emergency landings at the completion of one orbit can be made in the Atlantic off of Charleston, South Carolina or near Bermuda. At the end of the second passage, the emergency landing area is in the Atlantic off of Charleston, South Carolina. If a malfunction occurs during the early launch phase, emergency procedures will permit a water landing off of Cape Canaveral. Controlled retro firing will be used to contain most of the abort impact areas near Bermuda or in the vicinity of the Canary Islands.

(4). To implement Project Mercury, a world wide network of 18 ground-based tracking and instrumentation sites has been established together with a control center and a computing and communications center. Eleven of these sites are equipped with long range tracking radars; these compose the tracking network. Sixteen sites have telemetry receiving and display equipment. Six of the sites are equipped to transmit command control signals to the capsule; these are known as command sites. Sixteen of the sites are equipped with capsule communications equipment that provides two-way voice contact with the astronaut. In addition, all of the sites are linked with the computing and control centers by a ground communications network. See figure 1-1 for the locations of the sites.

C. SITE FUNCTIONS

From orbit insertion until landing, the tracking and ground instrumentation systems will provide continuous prediction of the capsule location; they will monitor the status of the capsule and astronaut; and they will permit the command functions necessary for the mission. The functions of the tracking and ground instrumentation systems are completed when the capsule has landed and the best possible information on the landing point location has been supplied to a recovery team. Table 1-I lists the various sites and the functions of each.

D. SYSTEM FUNCTION

The function of the acquisition system is to supply pointing data (capsule azimuth and elevation) to the radars, active acquisition aid, receiving antenna, and transmitting antenna. Pointing data is made available to the automatic-tracking radars and active acquisition aid for initial acquisition of the capsule and to aid in quick re-acquisition if capsule tracking is lost during a pass over the site. During a pass, the other antennas normally are pointed at all times by data from the acquisition system.

1-2. EQUIPMENT SUPPLIED

Table 1-II lists the equipment supplied for the acquisition system. A number of items of test equipment shown in this table are also used for other systems on the site. Such items are listed in the applicable manuals of the other systems as well as in this manual.

1-3. DESCRIPTION OF ACQUISITION SYSTEM

A. GENERAL

The acquisition system at Kauai Island consists primarily of an acquisition

TABLE 1-I. FUNCTIONS OF EACH SITE

Site	S-Band Radar Tracking	C-Band Radar Tracking	Telemetry & Capsule Communications	Command Control
Cape Canaveral, Florida	X	X	X	X
Grand Bahama Island	-	-	X	-
Grand Turk Island	-	-	X	-
Bermuda	X	X	X	X
Atlantic Ship	-	-	X	-
Grand Canary Island	X	-	X	-
Kano, Nigeria	-	-	X	-
Zanzibar	-	-	X	-
Indian Ocean Ship	-	-	X	-
Muchea, Australia	X	-	X	X
Woomera, Australia	-	X	X	-
Canton Island	-	-	X	-
Kauai Island, Hawaii	X	X	X	X
Point Arguello, California	X	X	X	X
Guaymas, Mexico	X	-	X	X
White Sands, New Mexico	-	X	-	-
Corpus Christi, Texas	X	-	X	-
Eglin, Florida	X	X	-	-

data console, an active acquisition aid, and eight synchro line amplifiers. Each of these units and systems is described in the following paragraphs.

B. PHYSICAL DESCRIPTION

(1). ACQUISITION DATA CONSOLE (Figure 1-2)

The acquisition data console consists of two racks, each 59-5/8 inches high, 23-9/16 inches wide, and 22 inches deep, on which are mounted several panels. The two racks of the acquisition data console are bolted together and to the active acquisition aid control console, as shown in figure 1-2. A common writing surface extends 18-1/2 inches from the front of both consoles. Omitting blanks and starting at the top, the panels of the left rack of the acquisition data console are an intercom panel, an acquisition data panel (number 1), a synchro line amplifier (number 1), and

TABLE 1-II. EQUIPMENT SUPPLIED

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT				
Acquisition Data Console	The Bendix Corporation Bendix Radio Division	R651465-2	1	MS-116, Acquisition System Manual - Operation & Maintenance - Kauai, Hawaii
Active Acquisition Aid each consisting of:	Cubic Corporation	-	1	ME-129, Instruction Manual for Active Acquisition Aid (AGAVE)
Triplexer (Multiplexer)			1	
Diplexer (Multiplexer)			2	
RF Housing			1	
Amplidyne			2	
Receiver Cabinet			1	
Servo Cabinet			1	
Control Console			1	
Boresight Antenna and Transmitter			1	
Antenna and Pedestal consisting of:				
Quad helix array			1	
HF dipole & reflector			1	
Ground plane			1	
Hybrid ring			4	
Pedestal			1	
Synchro Line Amplifier	Milgo Electronic Corporation	1007-10B	8	ME-132, Instruction Manual, Synchro Line Amplifier
Synchro Reference Step-Up Transformer	The Bendix Corporation Bendix Radio Division	A665084-1	1	MS-116, Acquisition System Manual - Operation and Maintenance - Kauai, Hawaii
Synchro Reference Step-Down Transformer	The Bendix Corporation Bendix Radio Division	A665085-1	5	MS-116, Acquisition System Manual - Operation and Maintenance - Kauai, Hawaii

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT (Cont.)				
Master-Slave Relay Panel	The Bendix Corporation Bendix Radio Division	653770-1	1	MS-116, Acquisition System Manual - Operation and Maintenance - Kauai, Hawaii
Antenna Drive Power Cutoff Switch and Warning Light	The Bendix Corporation Bendix Radio Division	L653858-1	1	MS-116, Acquisition System Manual - Operation and Maintenance - Kauai, Hawaii
TEST EQUIPMENT				
Oscilloscope	Hewlett-Packard Company	130B	1	ME-200, Operating and Servicing Manual, Model 130B/BR Oscilloscope
Oscilloscope	Tektronix, Incorporated	545A	2	ME-202, Instruction Manual, Type 535A Type 545A, Cathode Ray Oscilloscopes
Wide-Band, High-Gain Calibrated Preamp	Tektronix, Incorporated	Type B	1	ME-204, Instruction Manual Type B Plug-In Unit
Dual-Trace Calibrated Preamplifier	Tektronix, Incorporated	Type CA	2	ME-203, Instruction Manual Type CA Plug-In Unit
Plug-In Preamplifier	Tektronix, Incorporated	Type L	1	ME-136, Instruction Manual Type L Plug-In Unit
Viewing Hood	Tektronix, Incorporated	H510	2	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode Ray Oscilloscopes (Accessories Section)
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-2)	1	-

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-1)	2	-
Unit Regulated Power Supply	General Radio Company	1201-B	1	ME-211, Operating Instructions, Type 1201-B Unit Regulated Power Supply
Regulated Power Supply	Lambda Electronics Corporation	71	1	ME-138, Instruction Manual, Lambda Regulated Power Supply Model 71
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	1	ME-231, Instruction Manual, Model 407 DC Power Supply
Square Wave Generator	Tektronix, Incorporated	Type 105	1	ME-230, Instruction Manual, Square Wave Generator Type 105
Signal Generator	Boonton Radio Corporation	225-A	1	ME-188, Instruction Manual, Signal Generator Type 225-A
Sweep Generator	Telonic Industries, Incorporated	HN-3	1	ME-120, Operating Instruction Manual
HF Signal Generator	Hewlett-Packard Company	606-A	1	ME-189, Operating and Servicing Manual
Function Generator	Hewlett-Packard Company	202-A	1	ME-205, Operating and Servicing Manual
Transfer Oscillator	Hewlett-Packard Company	540-B	1	ME-232, Operating and Servicing Manual
Wide Range Oscillator	Hewlett-Packard Company	200 CD	2	ME-198, Operating and Servicing Manual
Unit Oscillator	General Radio Company	1209-BL	1	ME-212, Operating Instructions, Types 1209-B and BL Unit Oscillators

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Universal EPUT and Timer	Beckman Instruments, Incorporated	7370	1	ME-196, Instruction Manual, Model 7370 Universal EPUT and Timer
Frequency Converter	Beckman Instruments, Incorporated	7570 through 7573	1	ME-197, Instruction Manual, Model 7570 Series Frequency Conversion Equipment
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No. A683917)	1	ME-102, Instruction Manual, Noise and Field Intensity Meter
Power Output Meter	The Daven Company	OP-962	1	ME-154, Instruction Manual
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	1	ME-118, Instruction Manual, Model 801 Potentiometric DC Voltmeter
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	3	ME-190, Operating and Servicing Manual
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	2	ME-191, Operating and Servicing Manual, 400D/H/L Vacuum Tube Voltmeter
Volt-Ohm-Milliammeter	Triplett Electrical Instrument Company	630-PL	5	ME-193, Instruction Manual, Model 630-PL Volt-Ohm-Milliammeter
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	1	ME-194, Operating and Servicing Manual, 330B/C/D Noise and Distortion
RF Detector	Telonic Industries, Incorporated	XD-3	2	ME-135, Instruction Manual
Tube Analyzer	Triplett Electrical Instrument Company	3444	1	ME-199, Instruction Manual, Model 3444 Tube Analyzer

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Variac	General Radio Company	W10MT	1	ME-246, Operating Instructions W10 Variac
Attenuator Pad	Telonic Industries, Incorporated	TGC-50	2	-
Miscellaneous Cables and Accessories	-	-	-	-

a dual power supply. The panels in the right rack are a second acquisition data panel (number 2) and three synchro line amplifiers (numbers 2, 3 and 4). Ten intercom phone jacks, in two sets of five each, are mounted on the front of the writing surface. Two relay chassis are mounted in the console, one on the left side and one on the right side of the left rack. Both of these chassis are near the acquisition data panel. Approximately in the center of the back of the left rack is mounted a synchro reference voltage step-down transformer. For information on the intercom panel, which is not functionally a part of the acquisition data console, refer to the Intrasite PBX and Intercom System Manual MS-109. For a description of the synchro line amplifiers, refer to paragraph 1-3.B.(2).

(a). <u>ACQUISITION DATA PANEL NUMBER 1</u>

Acquisition data panel number 1 is made up of displays, indicators and controls.

1. Across the top of the panel there are three pairs of synchro receivers which display azimuth and elevation data from the active acquisition aid, the Verlort radar, and the FPS-16 radar. There also is a pair of lamps which indicates the azimuth position of the active acquisition aid relative to the limits of cable wrap.

2. Just below the synchro receivers there is a row of indicator and switch assemblies, henceforth called simply indicators and switches. The indicators consist of a set of lamps, color filters over the lamps, and a white translucent screen on the front of the assembly. The switches are like the indicators with the addition of a multi-pole switch and a coil which when energized holds the switch contacts in their actuated position. The switch is initially actuated by depressing the screen. The screens of both the indicators and switches always appear white when the lamps are not lit. When the lamps are lit, the screens appear red, yellow, or green, depending on the color of the filters in the particular assembly.

3. On the left, below the active acquisition aid synchro receivers, are two indicators and one switch. One of the

indicators is labeled "AUTO" (yellow when lit). The other is a double indicator, the top half is labeled "SLAVED" (green when lit) and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

4. Two more indicators and a switch are below the Verlort radar synchro receivers. One of the indicators is labeled "VALID TRACK" (yellow when lit). The other is a double indicator; the top half is labeled "SLAVED" (green when lit) and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

5. Beneath the FPS-16 radar synchro receivers are two indicators and a switch which have the same labels and colors when lit as the corresponding indicators and switch associated with the Verlort radar.

6. In the lower left-hand corner of the panel there is one indicator and two switches. The indicator is labeled "NO DATA ON BUS" and is red when lit. Both of the switches are labeled "28V SUPPLY" and are either red or green when lit.

7. In the bottom center and bottom right-hand corner of the panel there is a pair of synchro transmitter-synchro receiver combinations, one for manual elevation settings and one for manual azimuth settings. The synchro transmitters are turned by handwheels on the front of the panel; the synchro receivers indicate the angular position of the transmitter rotors. Between the two receivers there is a switch labeled "SOURCE" (yellow when lit).

(b). <u>ACQUISITION DATA PANEL NUMBER 2</u>

Like acquisition data panel number 1, acquisition data panel number 2 is made up of displays, indicators and controls.

1. Across the top of the panel there are two pairs of synchro receivers which display azimuth and elevation data from the receiving antenna and transmitting antenna. Next to the

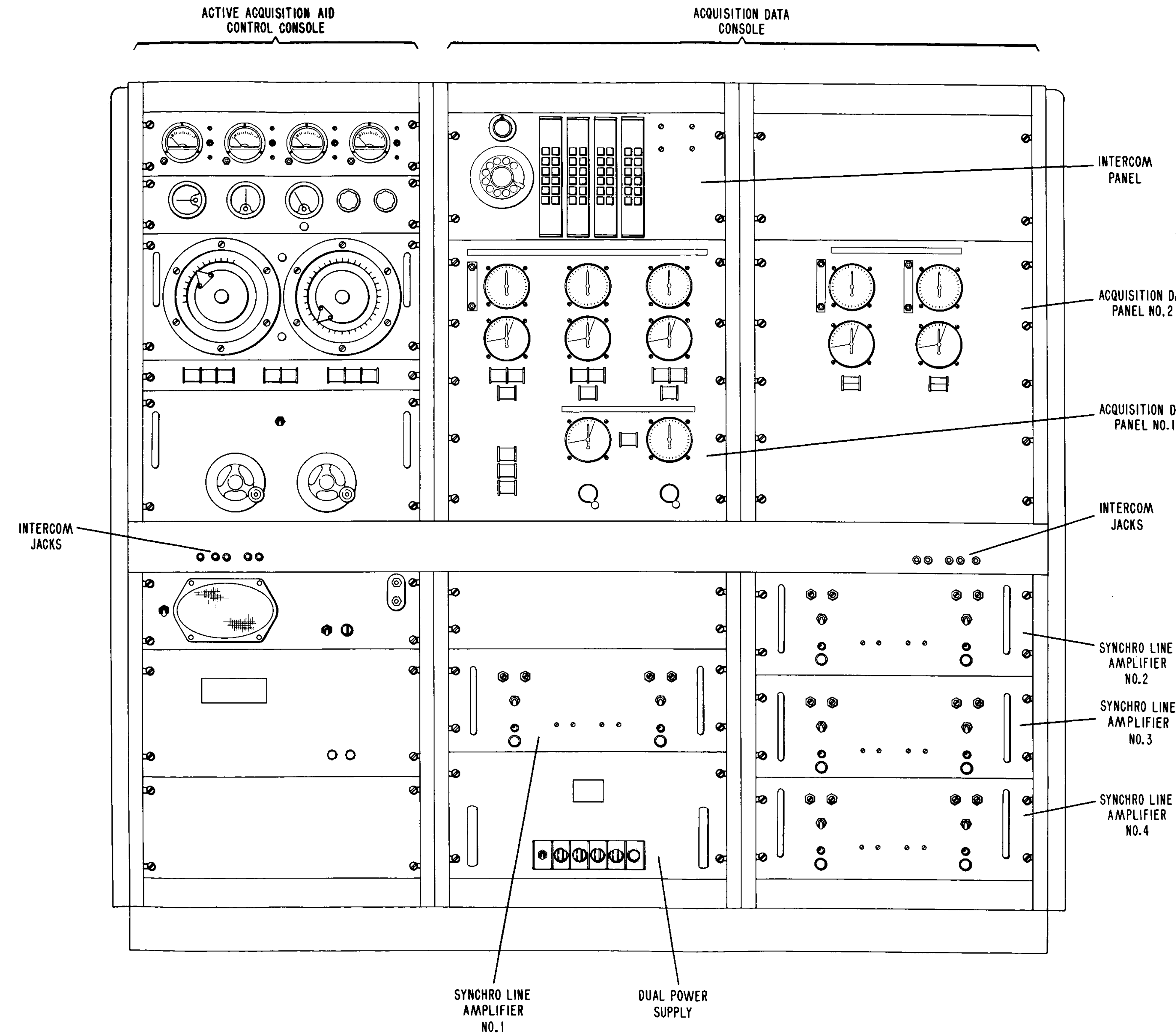


Figure 1-2. Acquisition Data Console and Active Acquisition Aid Control Console

receiving antenna and transmitting antenna azimuth synchro receivers there is a pair of lamps which indicates the antenna azimuth position relative to the limits of cable wrap.

2. Beneath the synchro receivers for the receiving and transmitting antennas are double indicators. The top half of each of these indicators is labeled "SLAVED" (green when lit) and the bottom half is labeled "MANUAL" (red when lit).

(c). DUAL POWER SUPPLY

Four power supply chassis together with one of the relay chassis described below make up two 28 VDC power supplies. Each power supply has a transformer, a silicon bridge rectifier, a fuse, and two filter capacitors on one chassis, and a filter choke and three filter capacitors on a second chassis. The dual power supply panel provides mounting for these four chassis. On the front of the panel are an off-on switch, which controls the primary power to both power supplies; a power-on indicator; and four line fuses—two for each power supply—in indicating-type fuse holders.

(d). RELAY CHASSIS

The relay chassis on the right side of the left rack of the acquisition data console provides mounting for two relays and four diodes which make up control circuitry for the 28 VDC power supplies. This chassis also provides mounting for two relays which when energized connect acquisition data from various sources to the acquisition bus. The chassis on the left side of the left rack provides mounting for two relays which protect synchros from damage in the event that the reference voltage is turned off in the console while it is still applied to either of the site radars.

(2). SYNCHRO LINE AMPLIFIERS

The synchro line amplifiers are mounted on 7-inch by 19-inch panels, four in the acquisition data console; one in each of the Verlort radar, PMR, and transmitter vans; and one in the FPS-16 Building. Each line amplifier consists of two pairs of amplifier units. Each pair of amplifier units makes up an amplifier channel; thus, a synchro line amplifier has two channels, one for azimuth information and the other for elevation information. On the front of the panel of each line amplifier there are two identical sets of controls. Each set consists of two line compensation controls, an off-on switch, a power-on indicator lamp, and a fuse. On the back of the panel there are two individual chassis, each contains two amplifier units (one amplifier channel) and a power supply. For a complete physical description of the synchro amplifier, refer to the applicable equipment manual.

(3). ACTIVE ACQUISITION AID (Figures 1-2 through 1-9)

The active acquisition aid, which is a system in itself, comprises eleven major units or assemblies: a control console, a receiver cabinet, a servo cabinet, an antenna and pedestal, two amplidynes, two diplexers, a triplexer, an RF housing, and a boresight antenna and transmitter.

(a). The active acquisition aid control console (shown with the acquisition data console in figure 1-2) has the same overall dimensions as one of the racks of the acquisition data console, to which it is bolted. The active acquisition aid control console consists of a rack in which are mounted a number of panels. The controls, indicators, and switches for the operation of the active acquisition aid are on these panels.

(b). The receiver cabinet contains the circuits of the active acquisition aid which develop the error signals used to position the antenna for tracking. The receiver cabinet is 23-9/16 inches wide, 22 inches deep and 77 inches high. It is bolted to the servo cabinet. (See figure 1-3.)

(c). The servo cabinet (figure 1-3) houses components of the servo system which positions the antenna in azimuth and elevation. Its overall physical dimensions are the same as those of the receiver cabinet, to which it is bolted.

(d). The active acquisition aid antenna and pedestal (figure 1-4) includes a quad-helix array, an HF dipole and reflector, a ground plane, four hybrid rings, and the pedestal itself.

(e). For physical descriptions of the amplidynes, diplexers, triplexer, RF housing, and boresight antenna and transmitter (figures

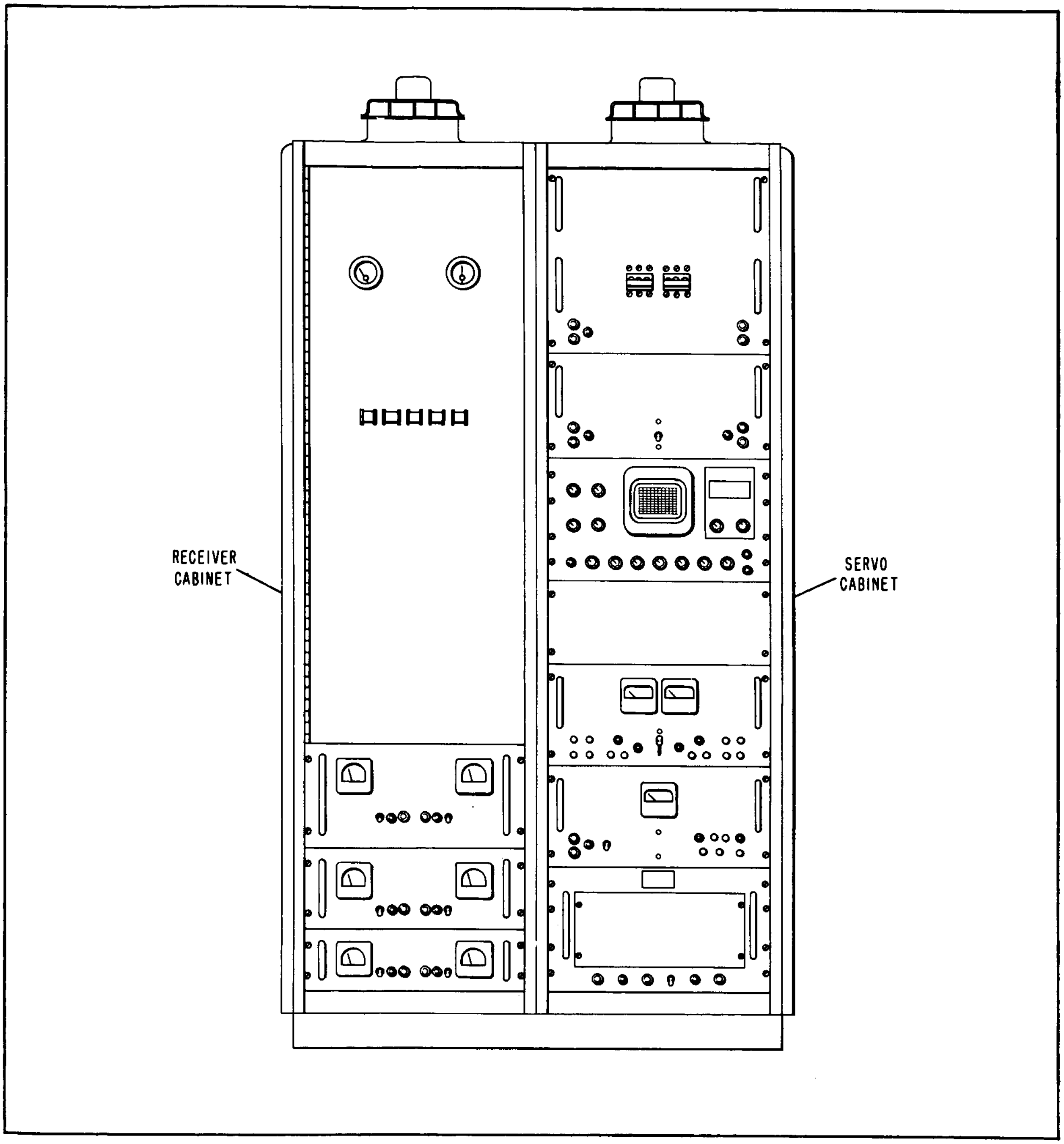


Figure 1-3. Active Acquisition Aid Receiver Cabinet and Servo Cabinet

1-5 through 1-9) and for complete physical descriptions of the control console, receiver cabinet, servo cabinet, and antenna and pedestal, refer to the applicable equipment manual.

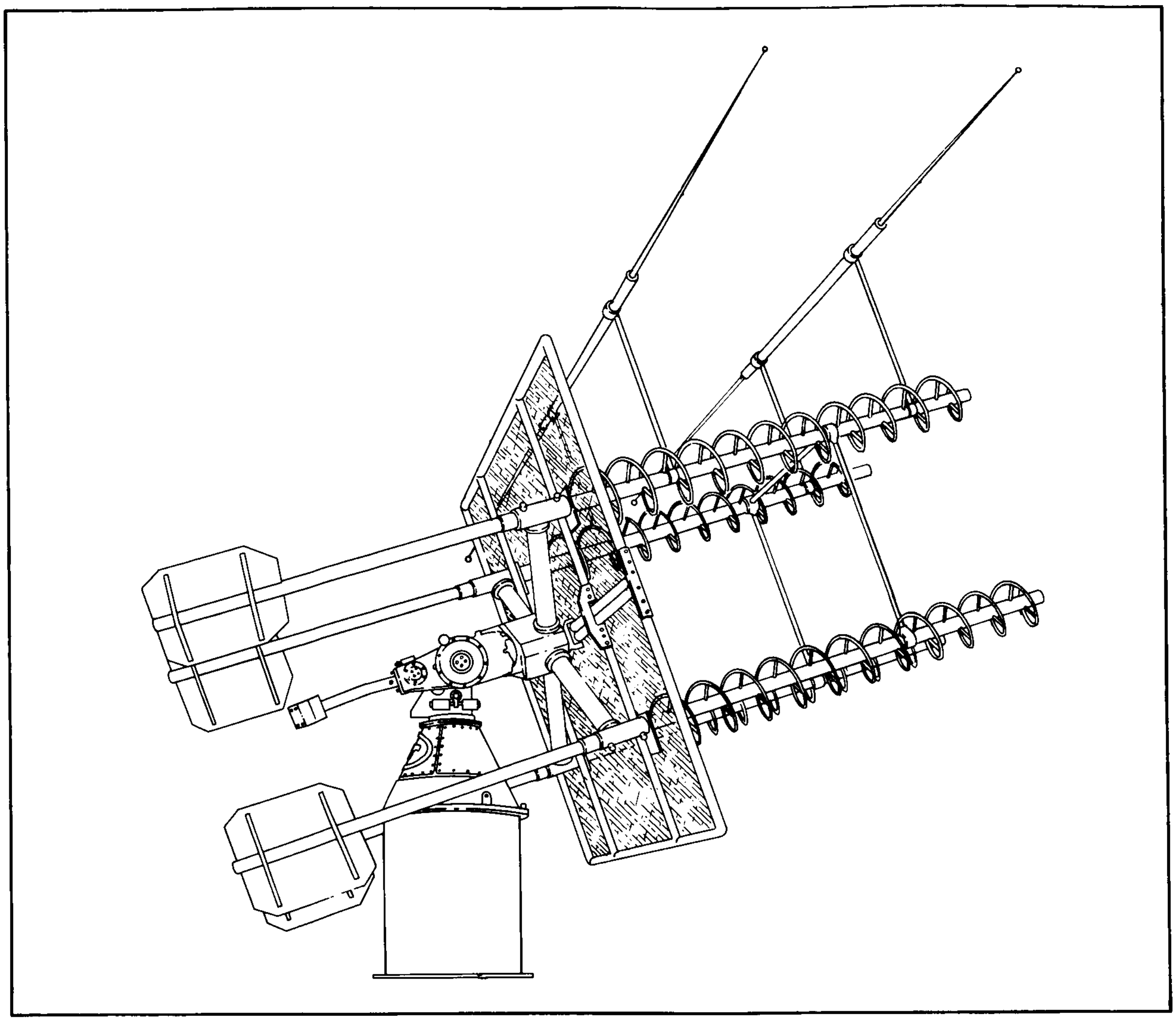


Figure 1-4. Active Acquisition Aid Antenna and Pedestal

(4). <u>ADDITIONAL EQUIPMENT</u>

(a). <u>SYNCHRO REFERENCE VOLTAGE TRANSFORMERS</u>

The synchro reference voltage step-up transformer is shown in figure 1-10. Its dimensions are 12-1/2 inches by 13 inches by 15 inches, and its weight is 150 pounds. A synchro reference voltage step-down transformer also is shown in figure 1-10. Its dimensions are 7-5/8 inches by 7-5/8 inches by 7-1/2 inches, and its weight is 35 pounds.

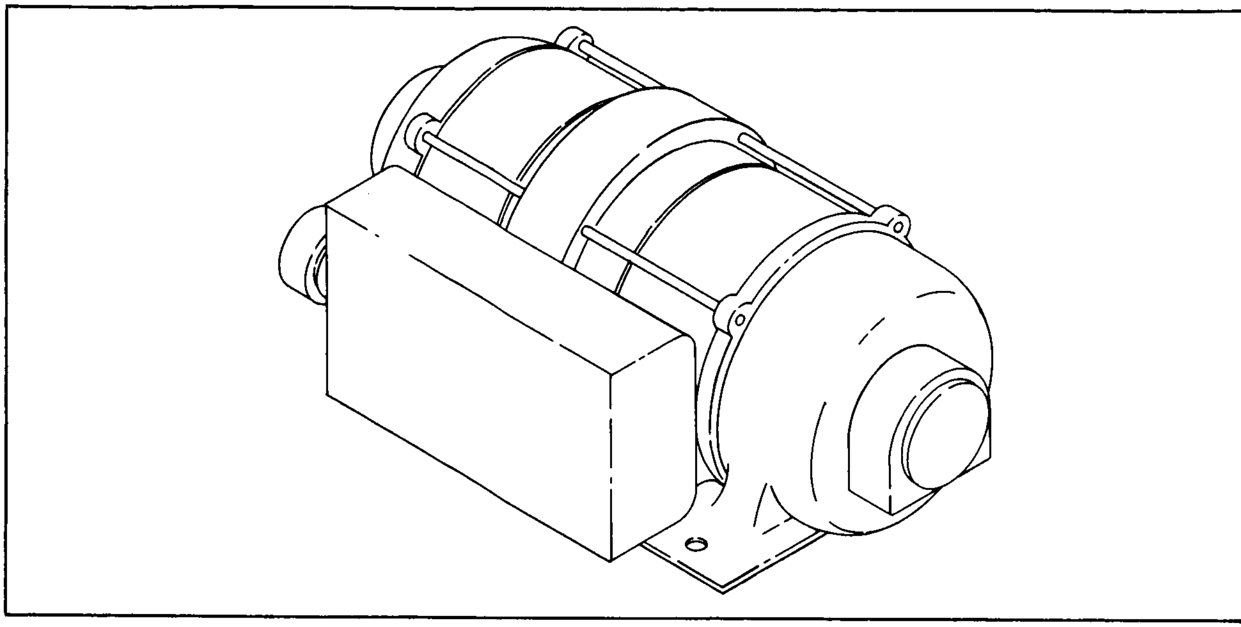


Figure 1-5. Active Acquisition Aid Amplidyne

(b). MASTER-SLAVE RELAY PANEL

The master-slave relay panel, shown in figure 1-11, consists of a control relay and two terminal boards.

(c). FPS-16 RADAR CONTROL RELAY

The FPS-16 radar control relay is relay K9011 in the FPS-16 data switch unit.

(d). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light (figure 1-12) contains a double-pole, single-throw switch and a red warning light mounted on a 6-inch by 12-3/4-inch frame.

C. FUNCTIONAL DESCRIPTION

(1). GENERAL

The following paragraphs describe the major components in the acquisition system.

(a). The acquisition system at Kauai Island is made up primarily of one acquisition data console and one active acquisition aid. It supplies acquisition and tracking information to the Verlort and

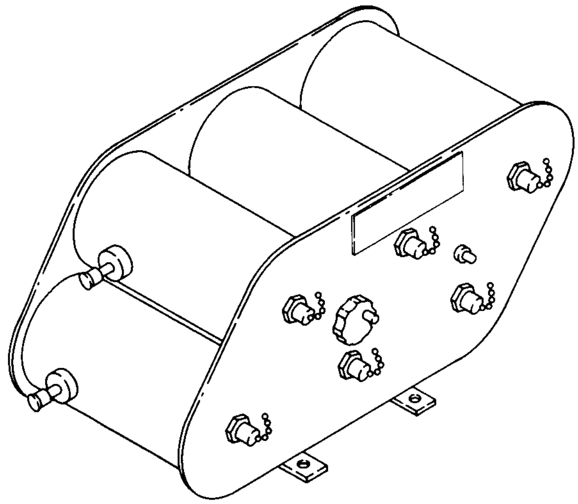


Figure 1-6. Active Acquisition Aid Diplexer (Multiplexer)

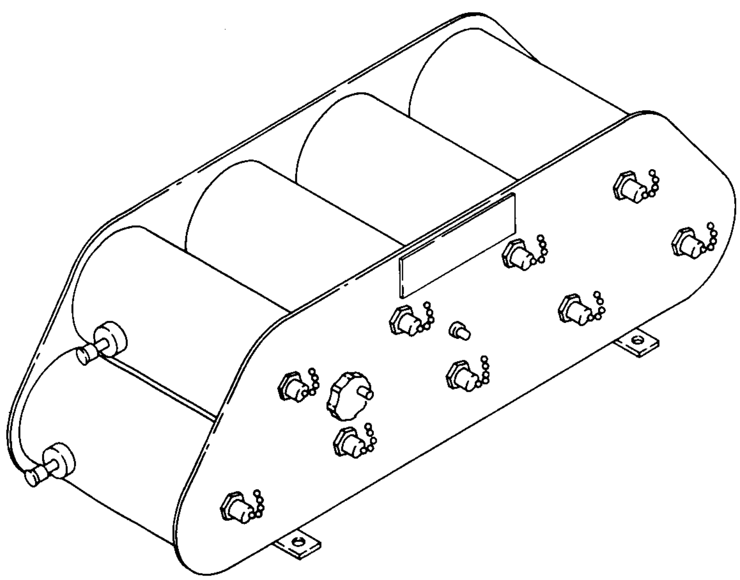


Figure 1-7. Active Acquisition Aid Triplexer (Multiplexer)

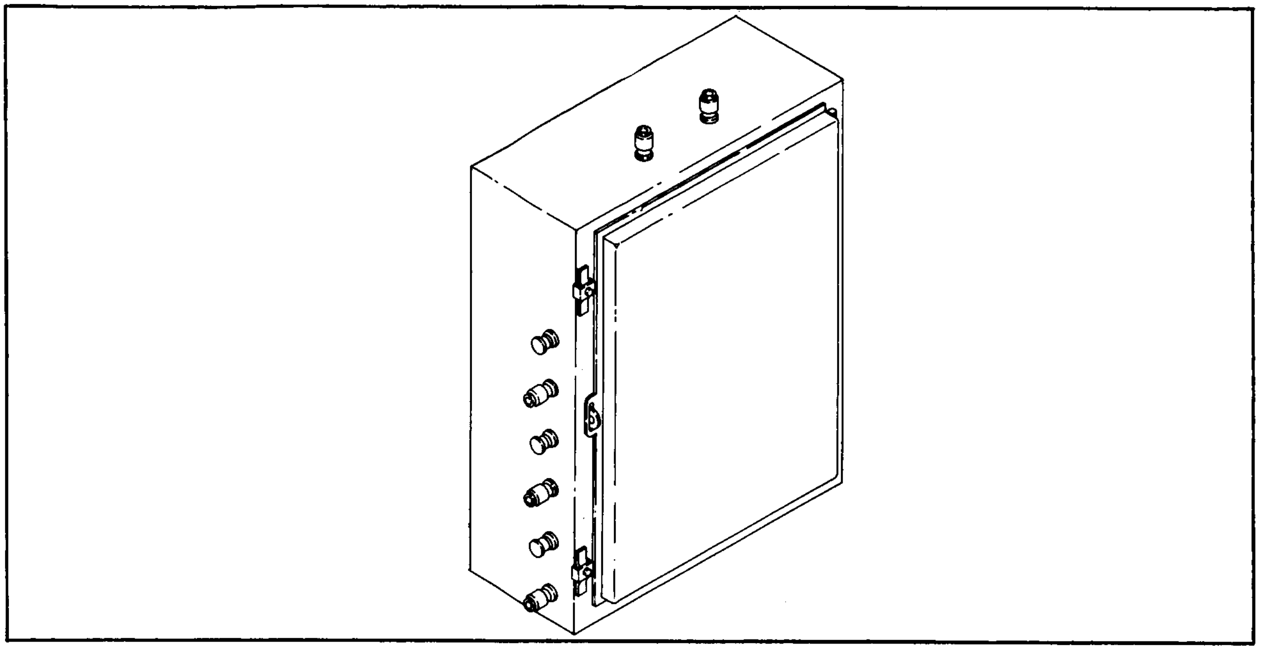


Figure 1-8. Active Acquisition Aid RF Housing

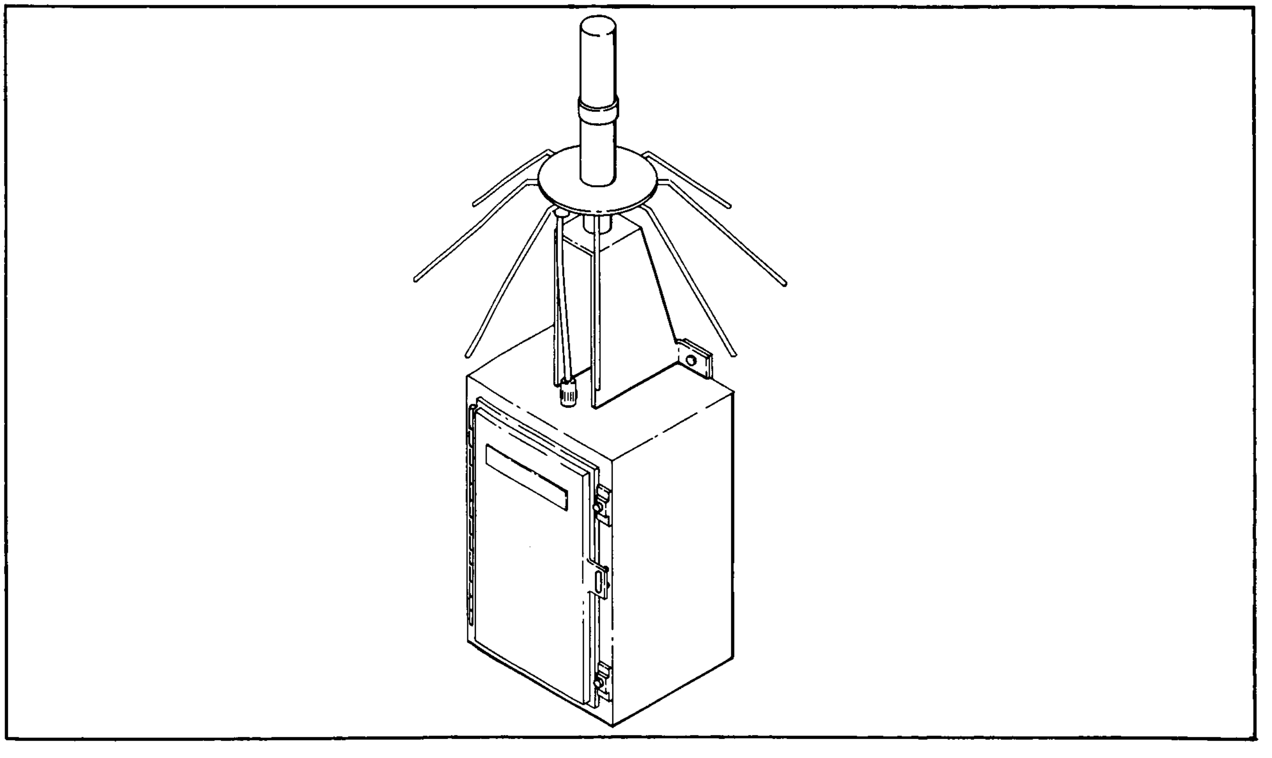


Figure 1-9. Active Acquisition Aid Boresight Antenna and Transmitter

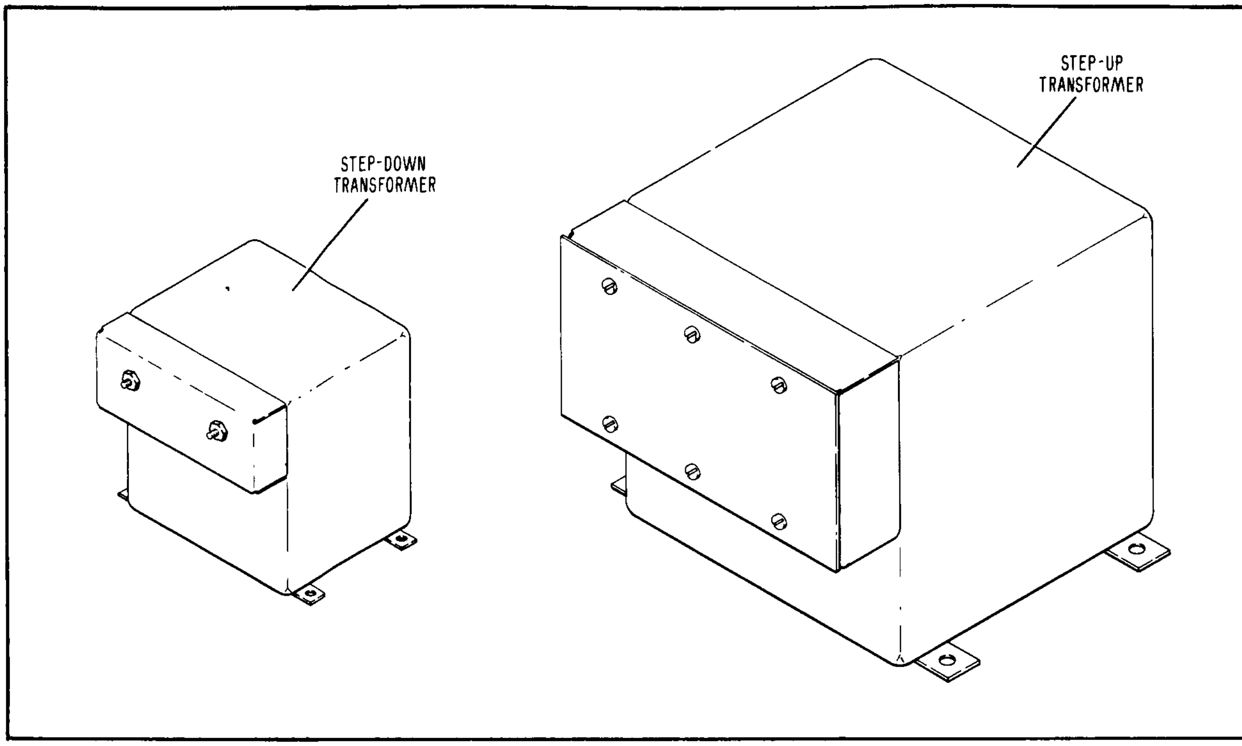


Figure 1-10. Synchro Reference Voltage Step-up and Step-down Transformers

FPS-16 radars, the PMR van, and the receiving and transmitting antennas.

(b). The function of the acquisition system is to supply the most accurate data available on the azimuth and elevation of the Mercury capsule to the steerable antennas on the site. Figure 1-13 illustrates this function. When no actual tracking information is available, predicted azimuth and elevation of the capsule at a given time are put onto the acquisition bus by the settings of synchro transmitters on the acquisition data console. The setting of these synchro transmitters is the manual input shown on figure 1-13. The information manually set into the acquisition data console is then available to the active acquisition aid, the Verlort and FPS-16 radars, the PMR van and the receiving and transmitting antennas. Once the active acquisition aid has acquired the capsule and is tracking it automatically or manually, its information on capsule azimuth and elevation is available for putting onto the acquisition

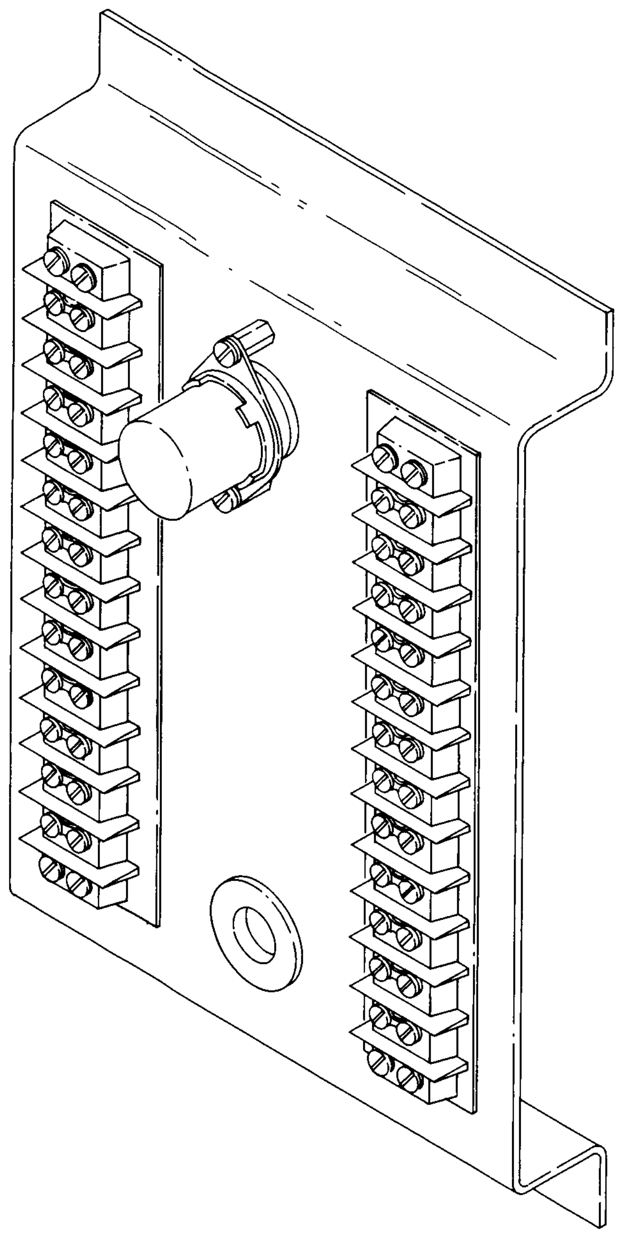


Figure 1-11. Master-Slave Relay Panel

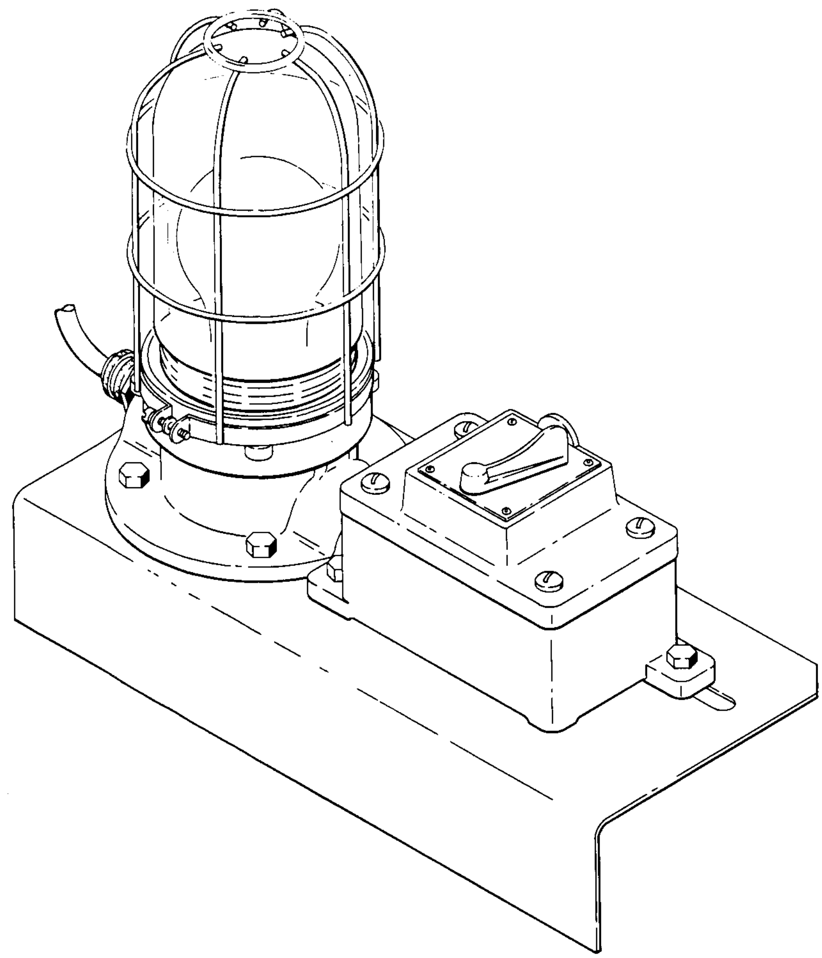


Figure 1-12. Antenna Drive Power Cutoff Switch and Warning Light

bus for use by all of the other steerable antennas on the site. It is, of course, possible that one of the radars will acquire the capsule before the active active acquisition aid. In this event, data from the tracking radar will be put onto the acquisition bus.

(c). Figure 1-14 is a simplified block diagram of the acquisition system. The acquisition bus, which distributes the two channels (azimuth and elevation) of acquisition data, is illustrated by heavy lines. Data from one of four sources is put onto the acquisition bus by the data source selector, which in actuality consists of several switches and relays on the acquisition data console. The

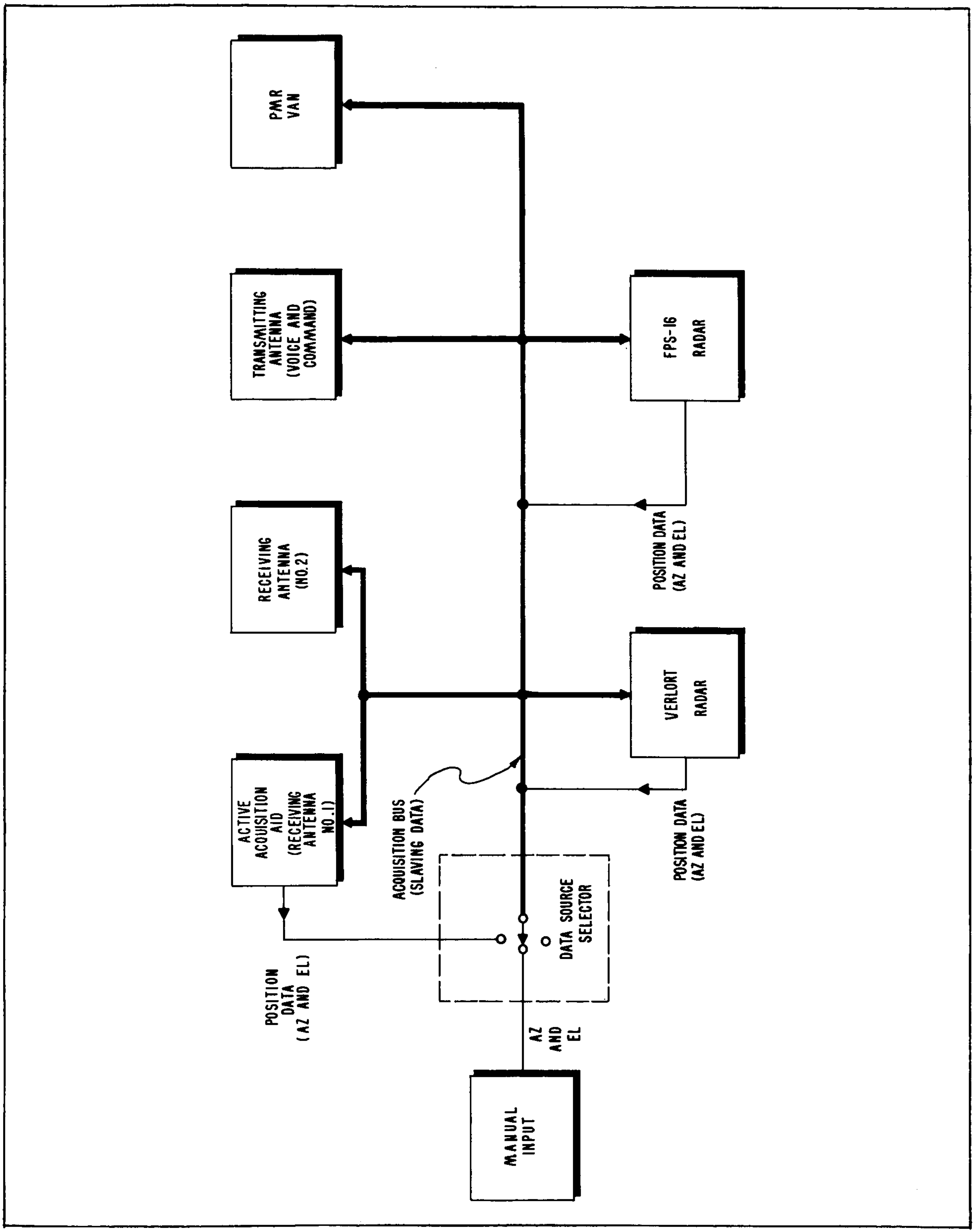


Figure 1-13. Basic Functions of the Acquisition System

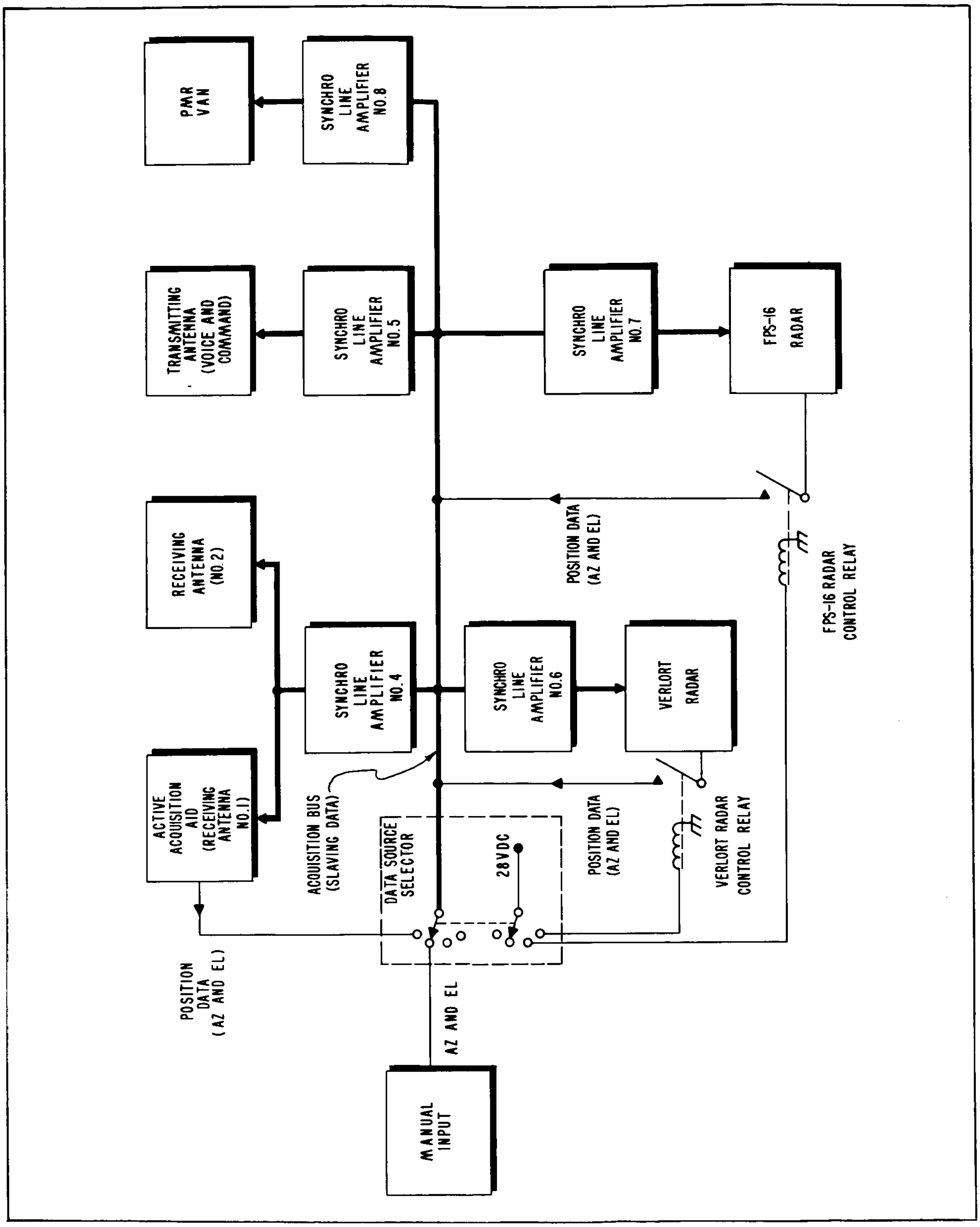


Figure 1-14. Acquisition System, Simplified Block Diagram

four sources are the manual input, the active acquisition aid, the Verlort and the FPS-16 radars. Except when one of the radars is the source, data on the acquisition bus goes from the acquisition data console through synchro line amplifier number 4 to the active acquisition aid and the receiving antenna, through synchro line amplifier number 5 to the transmitting antenna, through synchro line amplifier number 6 to the Verlort radar, through synchro line amplifier number 7 to the FPS-16 radar, and through synchro line amplifier number 8 to the PMR van. When one of the radars is the selected source of data, the data does not go through the acquisition data console, but is switched directly onto the acquisition bus by means of a radar control relay (which is energized by the data source selector on the console). Manual data is available for switching onto the acquisition bus whenever the synchro transmitters on the acquisition data console have the necessary information set into them, data from the radars is available whenever they are tracking automatically, and data from the active acquisition aid is available whenever it is tracking automatically or manually. Display data and operating mode information from the active acquisition aid, the radars, and the receiving and transmitting antennas are supplied to the acquisition data console. The paths of the display data and operating mode information are now shown on figure 1-14.

(2). ACQUISITION DATA CONSOLE

The acquisition data console is the control center of the acquisition system. The console contains indicator lights, synchro displays (receivers), and control switches. It also contains synchro-transmitters for putting predicted acquisition data into the system. The inputs to the console, other than primary power, are operating mode information in d-c form, synchro display data, and synchro position data. The operating mode information is used simply to light lamps which indicate the operating mode of the steerable antennas: for instance, automatic tracking, manual tracking, or slaved. Synchro position data is put on the acquisition bus for slaving the active acquisition aid, the radars, and the receiving and transmitting antennas. Synchro display data is displayed by means of synchro receivers on the console. This data is used only for monitoring purposes; it is not put on the acquisition bus for slaving purposes. The functions of the various indicators, displays and controls on the console are described in the following paragraphs; a simplified schematic is shown in figure 1-15.

(a). The d-c indications coming into the console from the transmitting antenna are "SLAVED" and "MANUAL" mode indications and a "CABLE WRAP" indication. The only synchro data from this antenna is azimuth and elevation display data, which comes in through synchro line amplifier number 3 and is displayed on a pair of synchro receivers on the acquisition data console. (Each of the synchro symbols on figure 1-15 represents a pair of synchros, one for azimuth data and one for elevation data.) The mode indications (controlled by an operator at the antenna servo rack) and the synchro displays allow the acquisition data console operator to monitor the operation of the antenna insofar as its positioning in azimuth and elevation is concerned. The cable wrap indication permits the acquisition data console operator to determine the azimuth position of the antenna relative to its cable wrap limits. (The rotation of the antenna is restricted to 540 degrees because of cabling which wraps around the pedestal as it turns.)

(b). The d-c indications and synchro data coming into the acquisition data console from the receiving antenna are the same as those coming from the transmitting antenna (described in the paragraph above) except that the display data does not go through a synchro line amplifier.

(c). The mode indications from the Verlort radar are "VALID TRACK," "SLAVED," and "MANUAL." These indications show whether the radar is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The only synchro information coming into the acquisition data console from the radar is azimuth and elevation display data. It comes in through the synchro line amplifier number 1 and is displayed on a pair of synchro receivers on the acquisition data console. Verlort

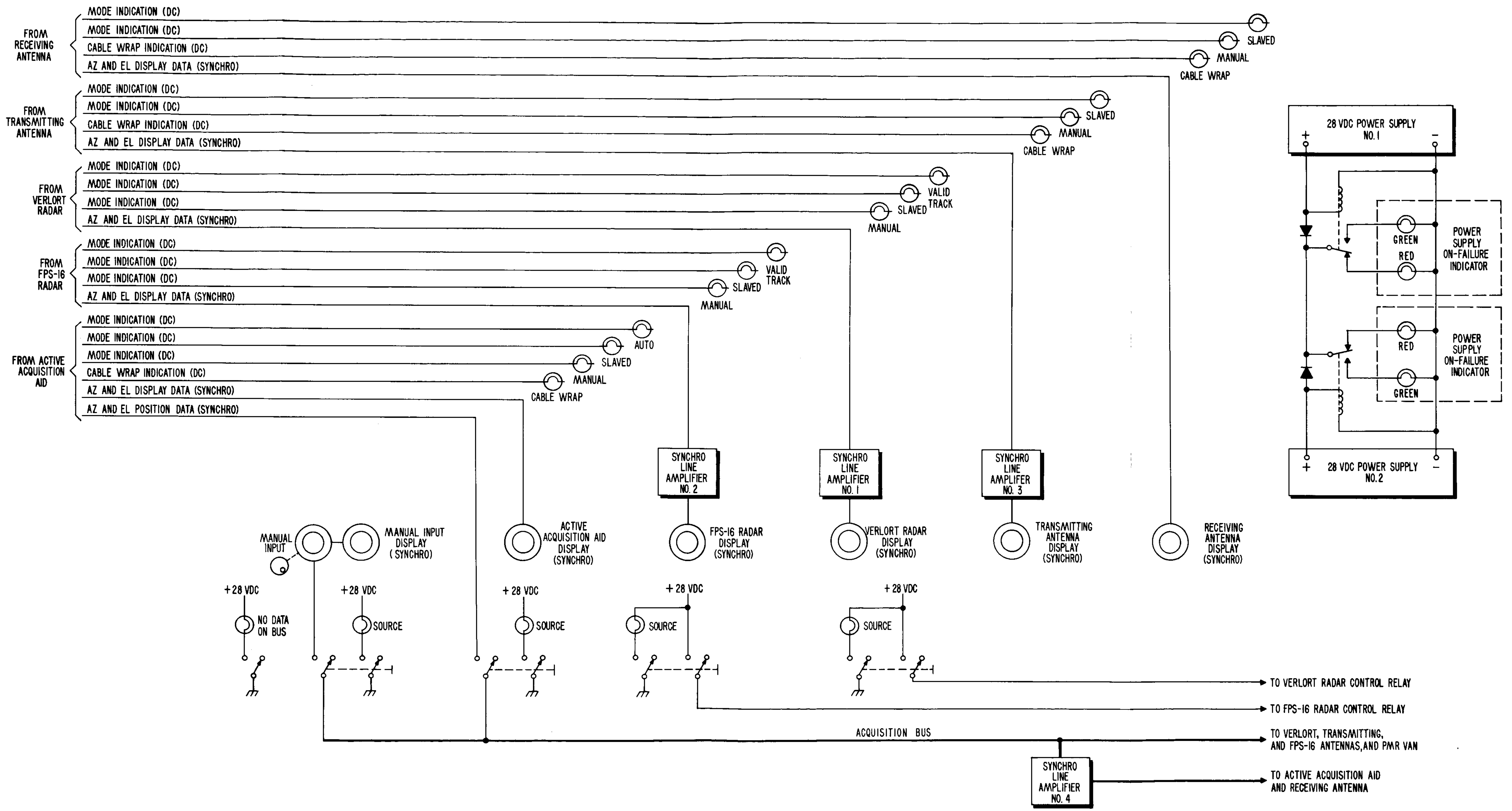


Figure 1-15. Acquisition Data Console, Simplified Schematic Diagram

radar position data does not come into the console at any time, but is put onto the acquisition bus by a relay in the radar which is controlled by a switch on the console. This switch and the d-c control for the radar relay are shown in simplified form on figure 1-15.

(d). The mode indications and the synchro data coming into the acquisition data console from the FPS-16 radar are the same as those coming from the Verlort radar (described in the paragraph above) except that the synchro display data comes through synchro line amplifier number 2.

(e). The d-c indications coming into the acquisition data console from the active acquisition aid are "AUTO," "SLAVED," and "MANUAL" mode indications and a "CABLE WRAP" indication. These indications show whether the active acquisition aid is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The cable wrap indication is the same as that of the receiving and transmitting antennas. Two sets of synchro information come into the console from the active acquisition aid: display data and position data. The display data is displayed on a pair of synchros on the console. The position data, which comes from a separate pair of synchro transmitters on the active acquisition aid, is available for switching onto the acquisition bus.

(f). Data from the manual input synchro transmitters on the console is displayed by a pair of synchro receivers and is available for switching onto the acquisition bus.

(g). Position data from the active acquisition aid, the radars, or the manual input is put onto the acquisition bus by means of switches and relays. These switches and relays are shown on figure 1-15 simply as switches beneath the manual, active acquisition aid, and radar displays. These controls, which make up the "data source selector" shown on figures 1-13 and 1-14, are electrically interlocked with each other and with a fifth, the switch in series with the "NO DATA ON BUS" indicator. Thus, data from only one source can be on the acquisition bus at any one time; and when there is no data on the bus, the "NO DATA ON BUS" indicator is lit. "SOURCE" indicators associated with the data selector switches show the source of data switched onto the acquisition bus.

(h). There are two 28 VDC power supplies on the acquisition data console, either one of which is capable of supplying all of the power needed to operate the console indicators and oontrols. Two power supplies are used to increase the reliability of the equipment, and provision is made to disconnect a power supply automatically when its voltage output drops below a certain level. The circuitry which performs this action is shown in simplified form on figure 1-15. Across the output of each of the power supplies there is a control relay whose contacts apply 28 VDC to either a red or a green lamp in the "power supply on-failure indicator." When both power supplies are on and functioning properly, both of the control relays are energized and the green lamps are lit in both indicators. Then, if the voltage output of one power supply drops below a certain value, the control relay associated with that power supply is de-energized and the red lamp in the indicator for that power supply is lit. De-energizing the control relay also causes primary power to be removed from the malfunctioning power supply. (The red indicator lamp is supplied with power from the other, normally operating power supply.) Note that when one power supply has been turned on and the other has not, a failed indication (red light) is given for the power supply not turned on; the control circuit gives the same indication for a condition of one power supply turned on and one off as it does for both turned on and one malfunctioning.

(3). SYNCHRO LINE AMPLIFIERS

The purpose of the synchro line amplifiers is twofold: (1) to isolate synchro receivers from other receivers and from a synchro transmitter; and (2) to provide a high load impedance for synchro transmitters and a low source impedance for synchro receivers, thus making the synchro data less subject to degradation due to loading effects of the transmission lines and synchro receivers. Each synchro line amplifier has two, identical amplifier channels, one for azimuth data and one for elevation data. Each of the amplifier channels consists of two amplifier elements and a power supply. Each of the amplifier elements is, in itself, a four stage feedback amplifier. The amount of feedback is adjusted so that each amplifier element has a voltage gain of one; thus each amplifier channel in the synchro line amplifier has a voltage gain of one, and the voltage applied to the synchro receivers connected to the amplifier is the same as that put out by the synchro transmitter connected to the amplifier. In this manner, isolation and a low impedance source for the synchro data are obtained without changing the voltage level of the data. For a detailed description of the synchro line amplifier, refer to the applicable equipment manual.

(4). ACTIVE ACQUISITION AID

(a). The active acquisition aid is an automatic angle-tracking device which provides acquisition data to the acquisition system for use by the other antennas on the site. It tracks the capsule in azimuth and elevation (but not in range) by means of the telemetry signals transmitted from the capsule, and puts out azimuth and elevation position and display synchro data.

(b). In addition to supplying data to the acquisition system, the active acquisition aid can be slaved (positioned in accordance with externally supplied azimuth and elevation data) to data from the site radars or from the manual inputs on the acquisition data console.

(c). The salient characteristics of the active acquisition aid are as follows:

Operating modes: automatic, slaved, manual

Operating frequency: either one of any two, preset frequencies in the range 225 to 260 MC

Tracking accuracy (at 10° per second tracking rate)

Azimuth: 0.5°

Elevation: 0.5° at angles greater than 15°
1.0° at angles between 10° and 15°

Antenna:

Type of array: quad-helix

Polarization: circular, right-hand sense

Elevation limits: minus 10° to plus 110°

Azimuth limit: 540°

Beamwidth: 20° at 3-db points

(d). For a complete functional description of the active acquisition aid, refer to the applicable equipment manual.

(5). ADDITIONAL EQUIPMENT

(a). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

The synchro reference voltage step-up transformers and step-down transformers are provided to reduce the amount of current transmitted over considerable distances. (See section II for the location of the transformers.)

(b). MASTER-SLAVE RELAY PANEL

The master-slave relay panel mounted in the Verlort van contains the Verlort radar control relay. This control relay, energized from the acquisition data console, enables position data from the radar to be put onto the acquisition bus without separate cabling for the position data between the radar and the acquisition data console.

(c). FPS-16 RADAR CONTROL RELAY

The relay used to control the FPS-16 radar is in the FPS-16 data switch unit. This relay (K9011) enables the position data from the FPS-16 to be put onto the acquisition bus in the same manner as that from the Verlort. It also is energized from the acquisition data console.

(d). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted on the active acquisition aid antenna tower. When open, it disconnects antenna drive motor power. The warning light is lit whenever the switch is closed. (See section II for the location of the cutoff switch and warning light.)

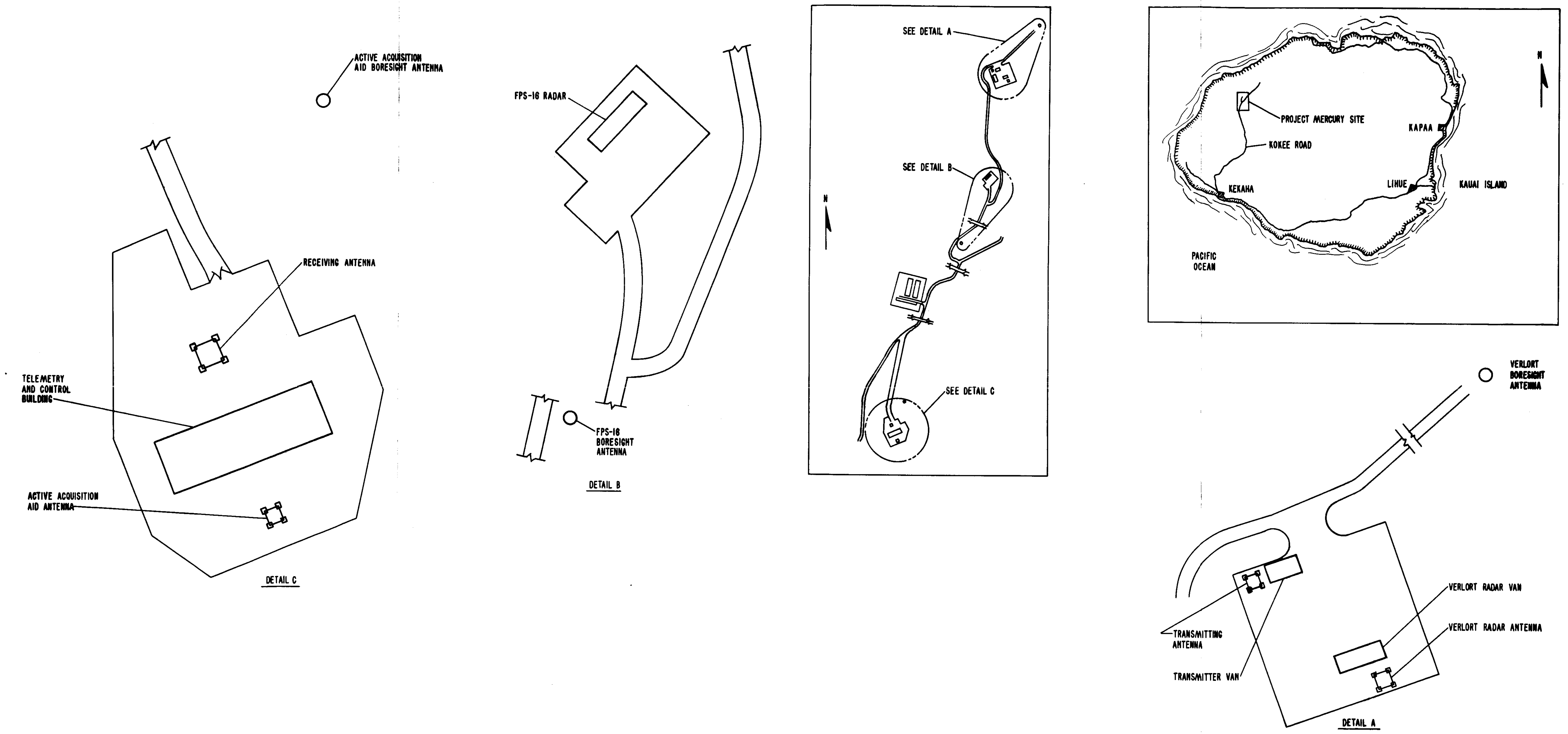


Figure 1-16. Site Layout, Kauai, Hawaii

1-4. SITE IMPLEMENTATION

A. GENERAL

(1). This paragraph deals with the allocation, location and housing of equipment for the acquisition system at the Kauai site.

(2). The nomenclature used in this manual for the antennas (other than radar) which are part of or are connected to the acquisition system differs slightly from the nomenclature used in the capsule communications and command control transmitting system manuals. For cross reference purposes the two sets of nomenclature are listed below:

ACQUISITION SYSTEM NOMENCLATURE	CAPSULE COMMUNICATIONS AND COMMAND CONTROL TRANSMITTING SYSTEM NOMENCLATURE
Active Acquisition Aid Antenna	Receiving Antenna No. 1
Receiving Antenna	Receiving Antenna No. 2
Transmitting Antenna	Voice and Command Transmitting Antenna

B. EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at the Kauai site is listed in table 1-II.

C. SITE DESCRIPTION

(1). SITE LAYOUT

Acquisition equipment at Kauai is in the telemetry and control building, on the active acquisition aid antenna tower just southeast of the building, and on a boresight tower north of the building. (See figure 1-16.)

(2). EQUIPMENT LOCATION

(a). ACQUISITION DATA CONSOLE

The acquisition data console is in the telemetry and control building in the location shown in figure 1-17.

(b). ACTIVE ACQUISITION AID

The active acquisition aid control console and receiver and servo cabinets are next to the acquisition data console as shown in figure 1-17. The amplidynes are just outside the front of the telemetry

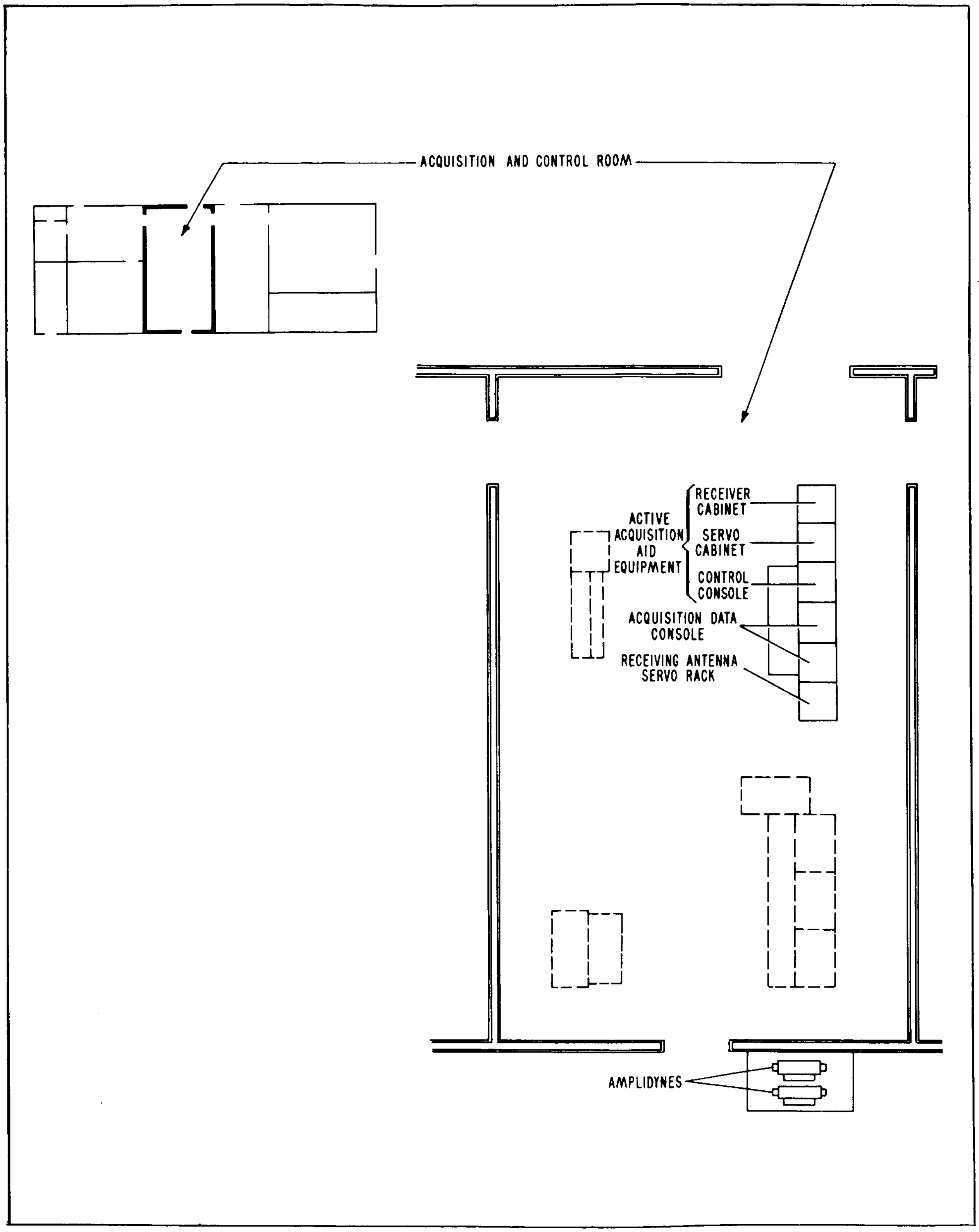


Figure 1-17. Acquisition System Equipment Layout, Telemetry and Control Building

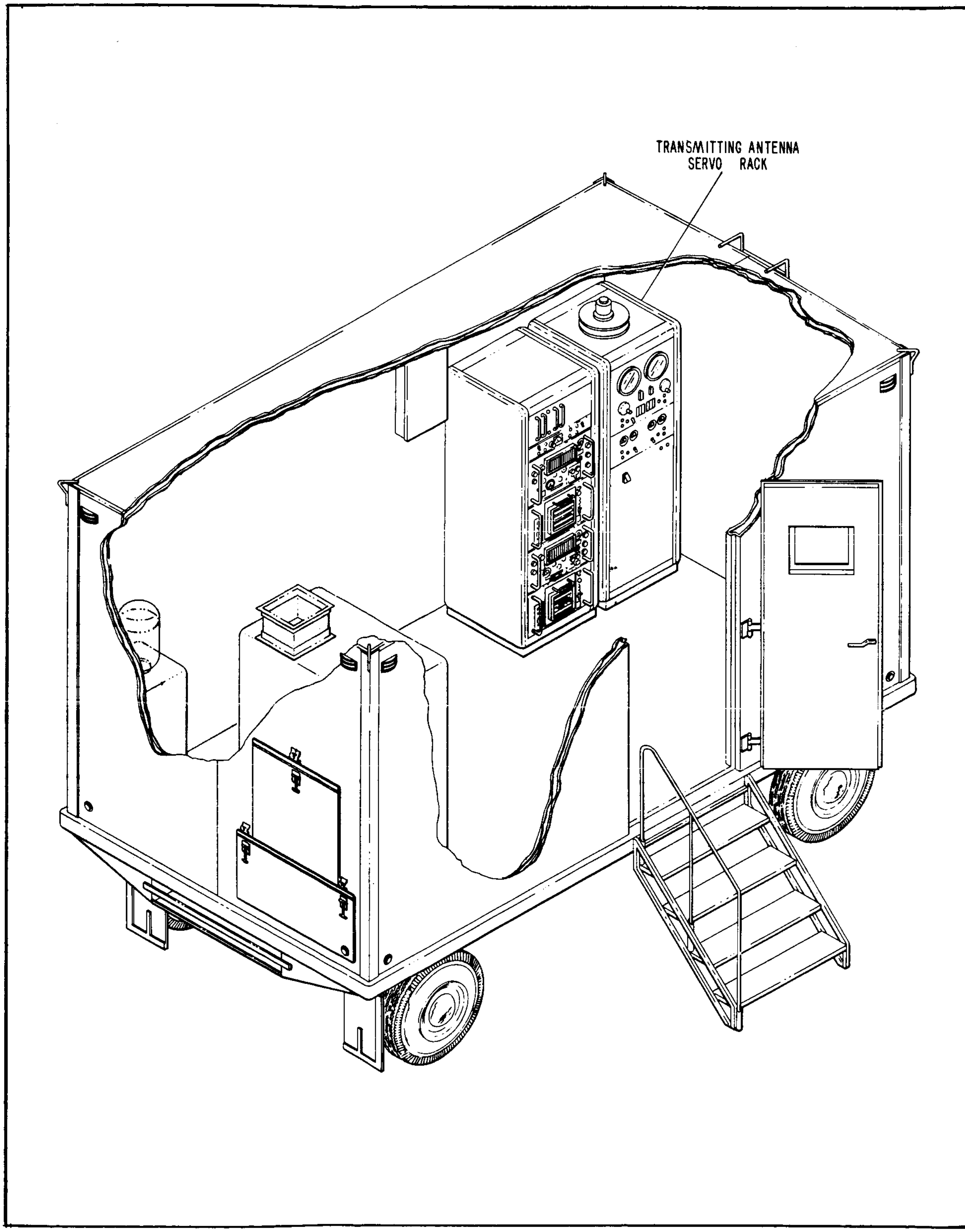


Figure 1-18. Location of Antenna Servo Rack in Transmitter Van

and control building. The diplexers, triplexer. and RF housing are mounted on the antenna tower (figure 2-5). The active acquisition aid boresight antenna is on the boresight tower, and the boresight transmitter is at the base of the boresight tower.

(c). RECEIVING ANTENNA

The receiving antenna, which is not a part of the acquisition system but is connected to it, is just northwest of the telemetry and control building (see figure 1-16).

(d). TRANSMITTING ANTENNA

The transmitting antenna, which is not a part of the acquisition system but is connected to it, is on a tower on the hardstand approximately 5100 feet north of the telemetry and control building (see, figure 1-16). As shown in figure 1-18, the transmitting antenna

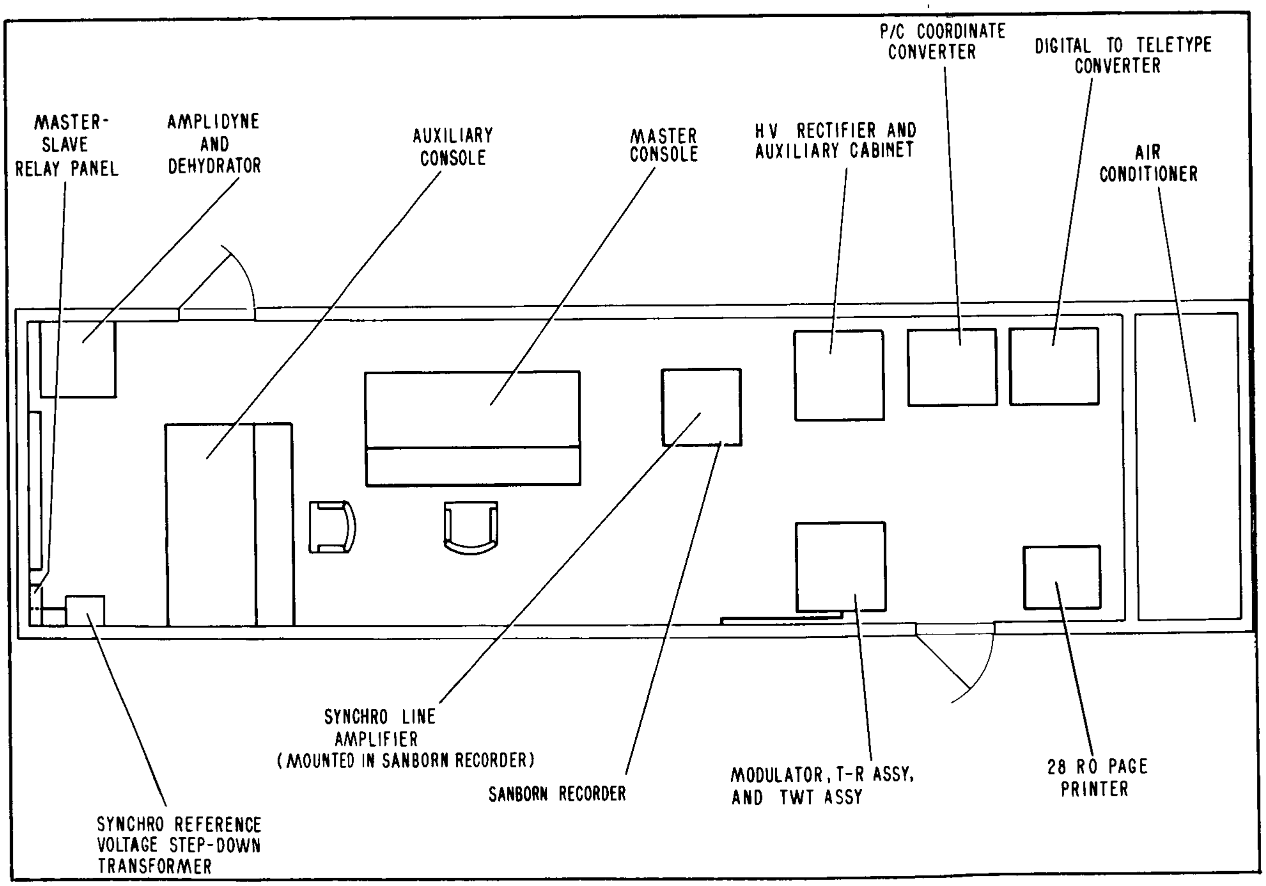


Figure 1-19. Acquisition System Equipment Layout, Verlort Van

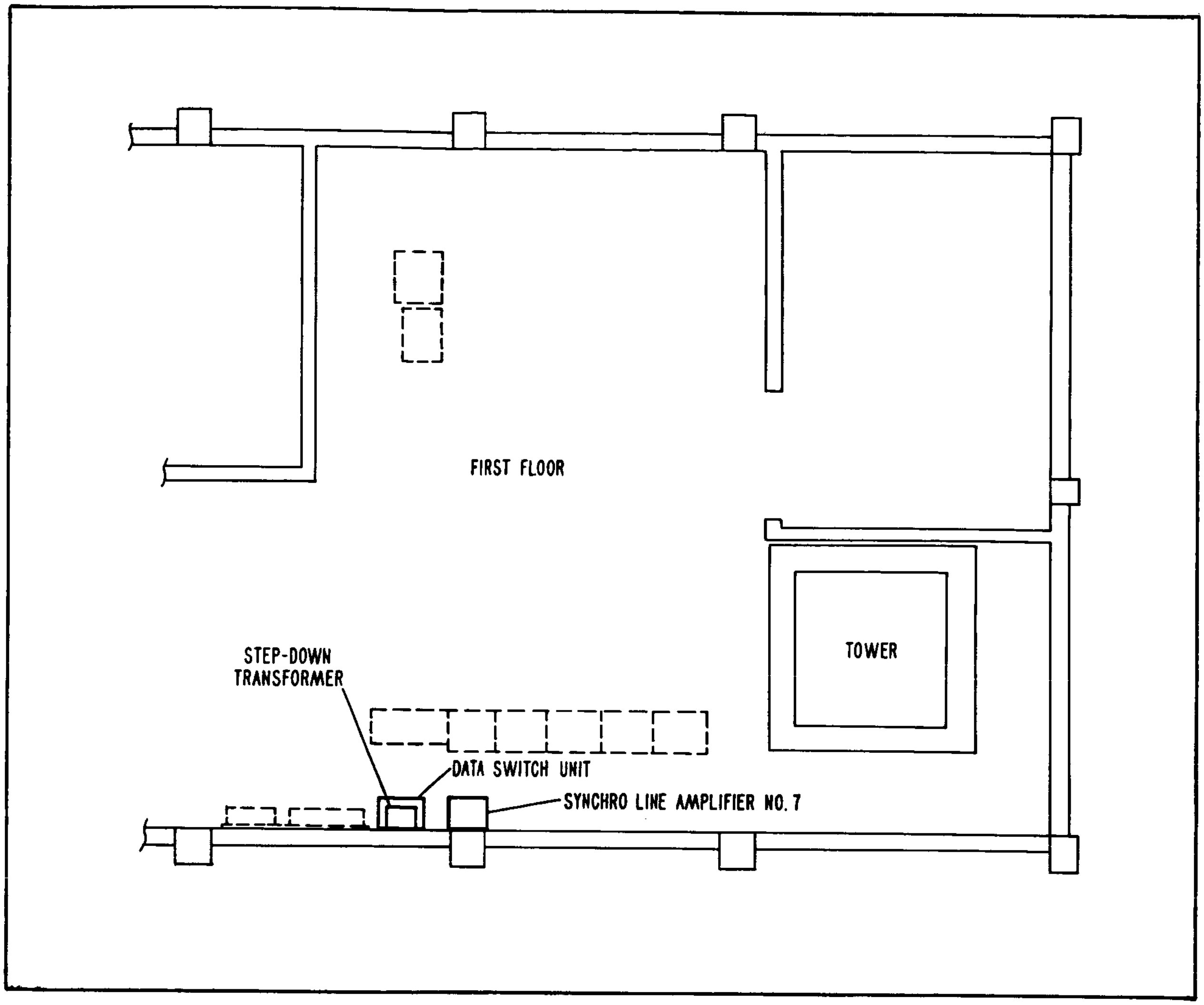


Figure 1-20. Acquisition System Equipment Layout, FPS-16 Building

servo rack is located in the transmitter van and contains a synchro line amplifier (number 5) and a synchro reference voltage step-down transformer.

(e). VERLORT RADAR

The Verlort radar, which is connected to the acquisition system, is contained in a van located in the same area as the transmitting antenna as shown on figure 1-16. A synchro line amplifier (number 6), the radar control relay (mounted on the master-slave relay panel), and a synchro reference voltage step-down transformer are in the van as shown in figure 1-19.

(f). FPS-16 RADAR

The FPS-16 radar, also connected to the acquisition system, is located in its own building approximately 4000 feet north of the telemetry and control building (see figure 1-16). The data switch unit, which contains the radar control relay, a synchro line amplifier (number 7), and a synchro reference voltage step-down transformer are in the building as shown in figure 1-20.

SECTION II
INSTALLATION

2-1. GENERAL

This section comprises instructions and other information for installing the equipment which makes up the acquisition system. Equipment installation on building floors, on antenna towers, and in other equipment are covered in separate paragraphs.

2-2. EQUIPMENT INSTALLATION

A. FLOOR MOUNTED EQUIPMENT

(1). CONSOLES AND CABINETS

The consoles and equipment cabinets in the acquisition system comprise two units. The acquisition data console and the active acquisition aid control console are bolted together and installed as a single unit. The other unit is made up of the active acquisition aid receiver and servo cabinets bolted together and installed as a single unit. Figure 1-17 shows the approximate location of the acquisition system equipment in the telemetry and control building. Figures 2-1 and 2-2 give the outline dimensions of the console and cabinet units. The console and cabinet units are secured to the floor by anchor bolts. Mounting hole locations and details of the anchor bolt installations are shown on figure 2-3. A complete listing of the hardware required for mounting the units is given in table 2-I.

(2). AMPLIDYNES

Each of the active acquisition aid amplidynes is bolted to a steel channel, which is secured to a concrete pad with anchor bolts. See figures 2-3.(B), 2-3(D), and 2-4 for details of the installation, and refer to table 2-I for the hardware required.

B. EQUIPMENT ON TOWERS

(1). ANTENNA AND PEDESTAL

The active acquisition aid antenna and pedestal are installed on a tower constructed for that purpose. The location of the tower is shown in figure 1-16. For instructions on the installation of the active acquisition aid antenna and pedestal, refer to the applicable equipment manual, listed in table 1-II.

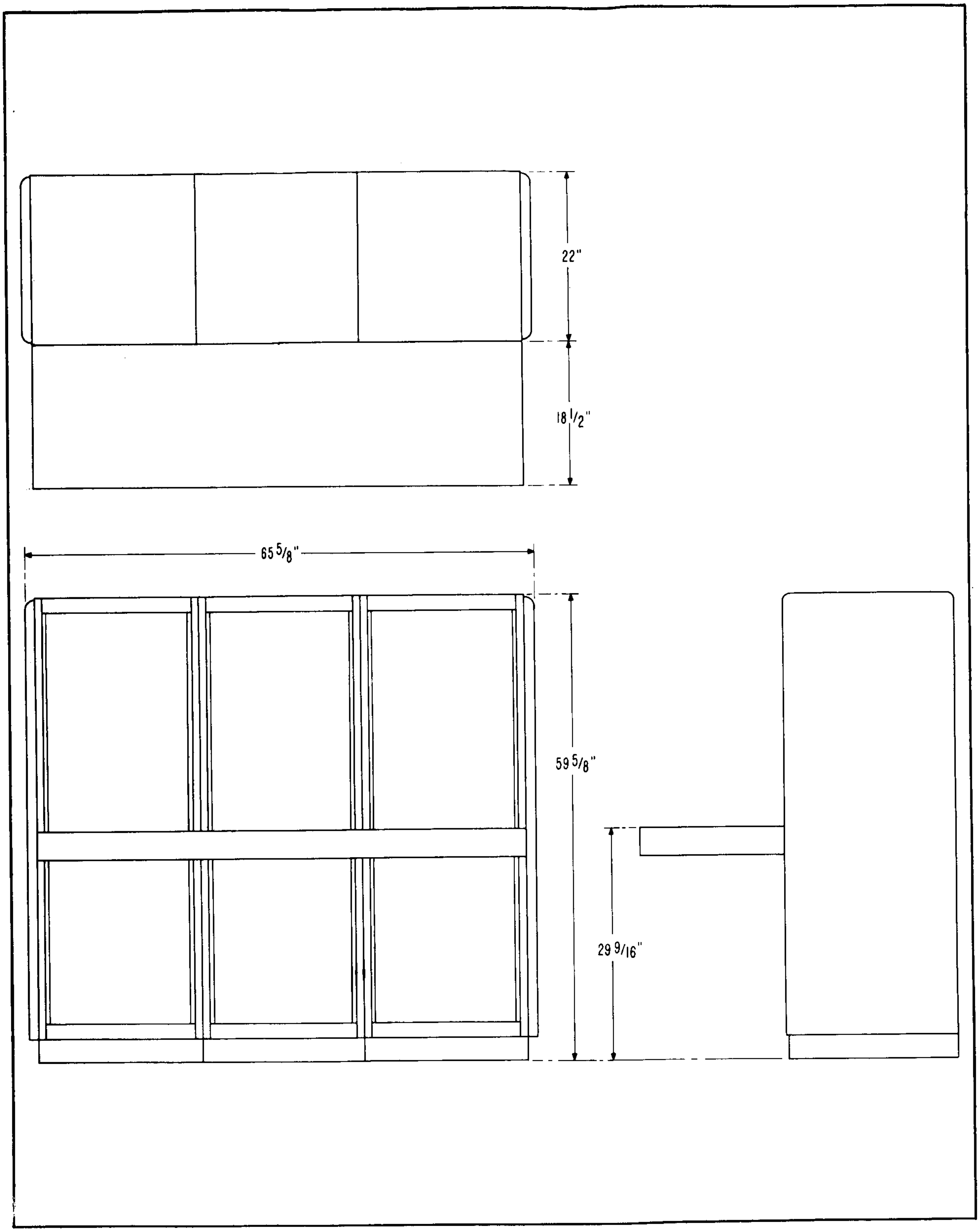


Figure 2-1. Console Outline Dimensions

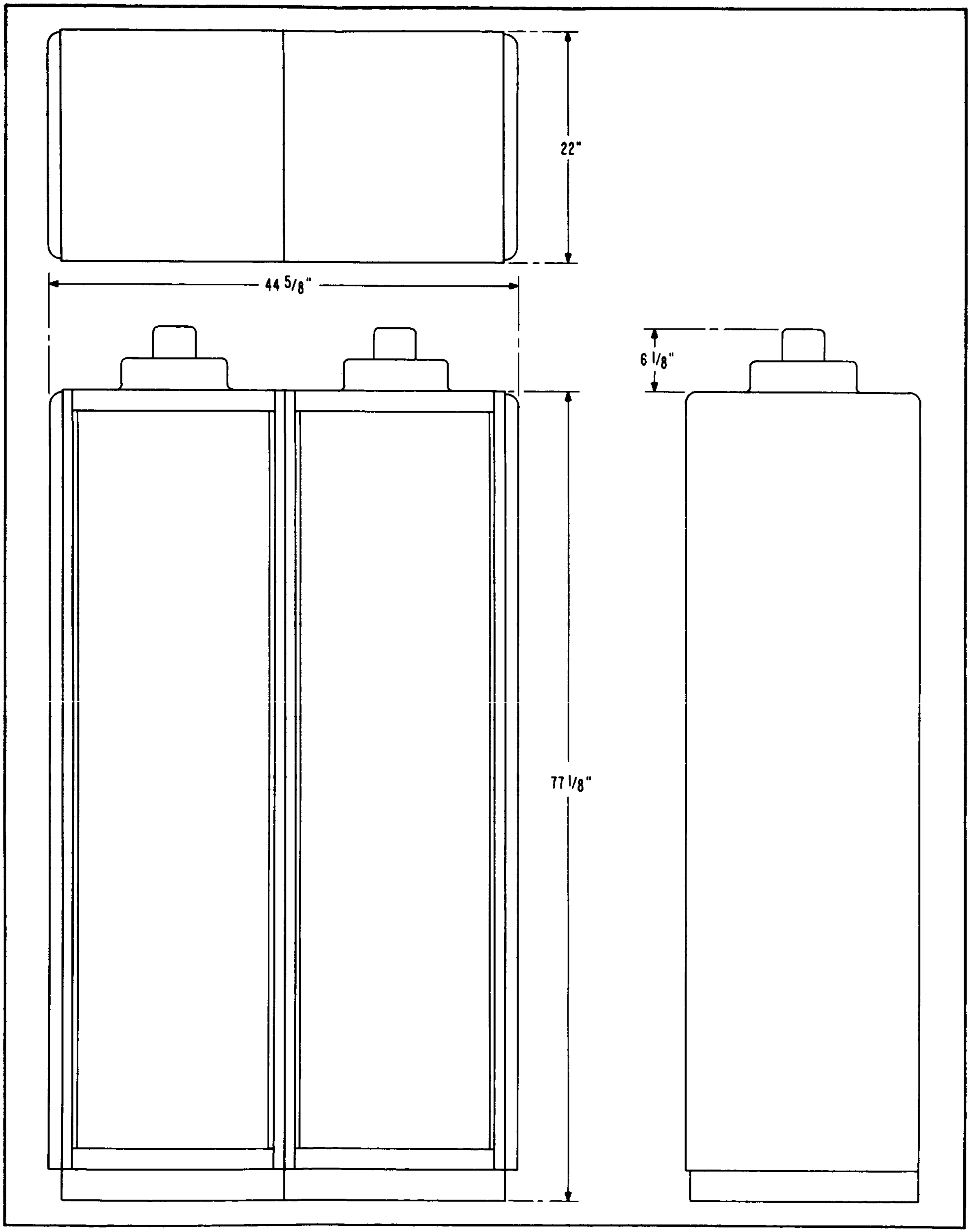


Figure 2-2. Active Acquisition Aid Receiver and Servo Cabinet Outline Dimensions

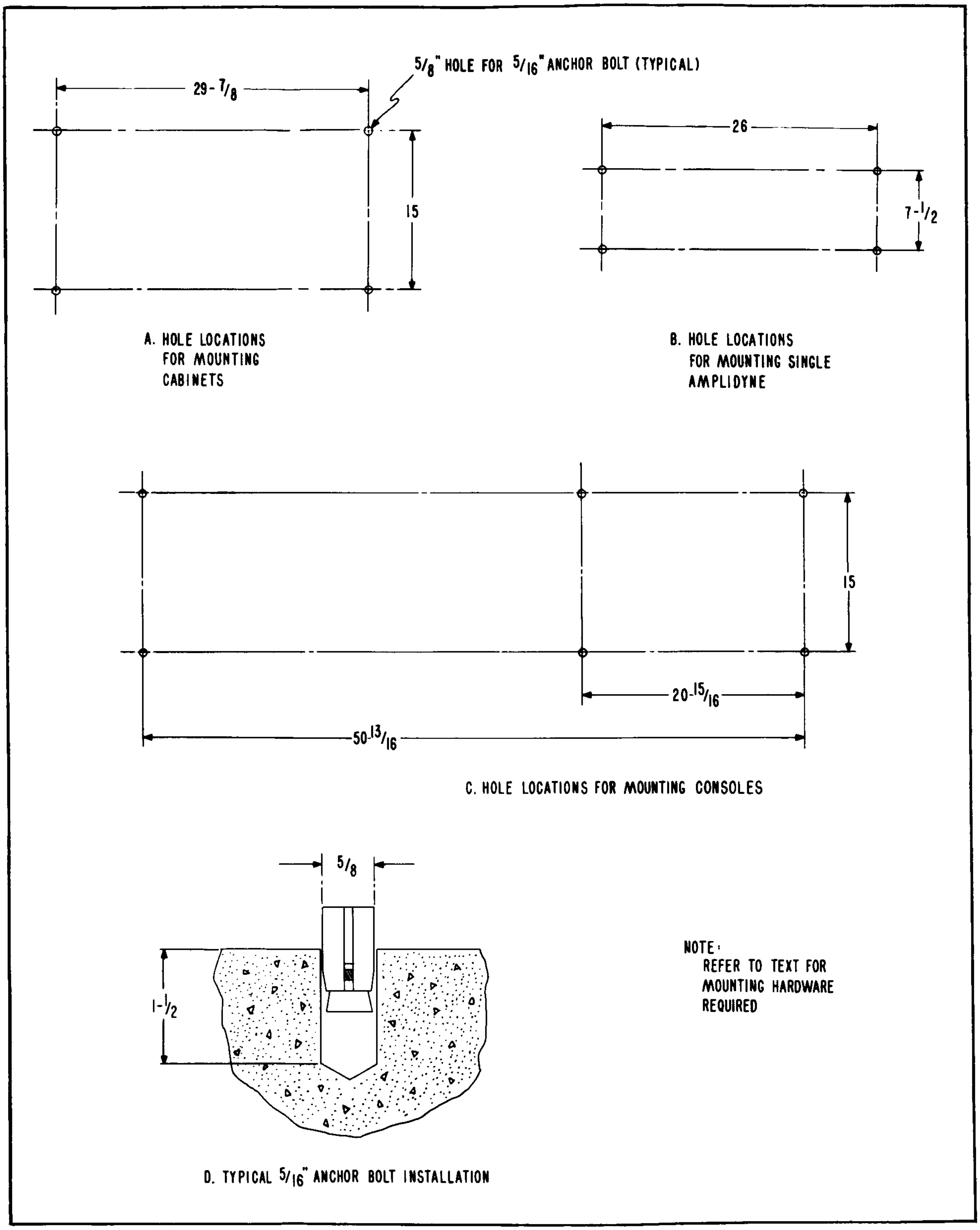


Figure 2-3. Floor and Pad Mounting Hole Locations

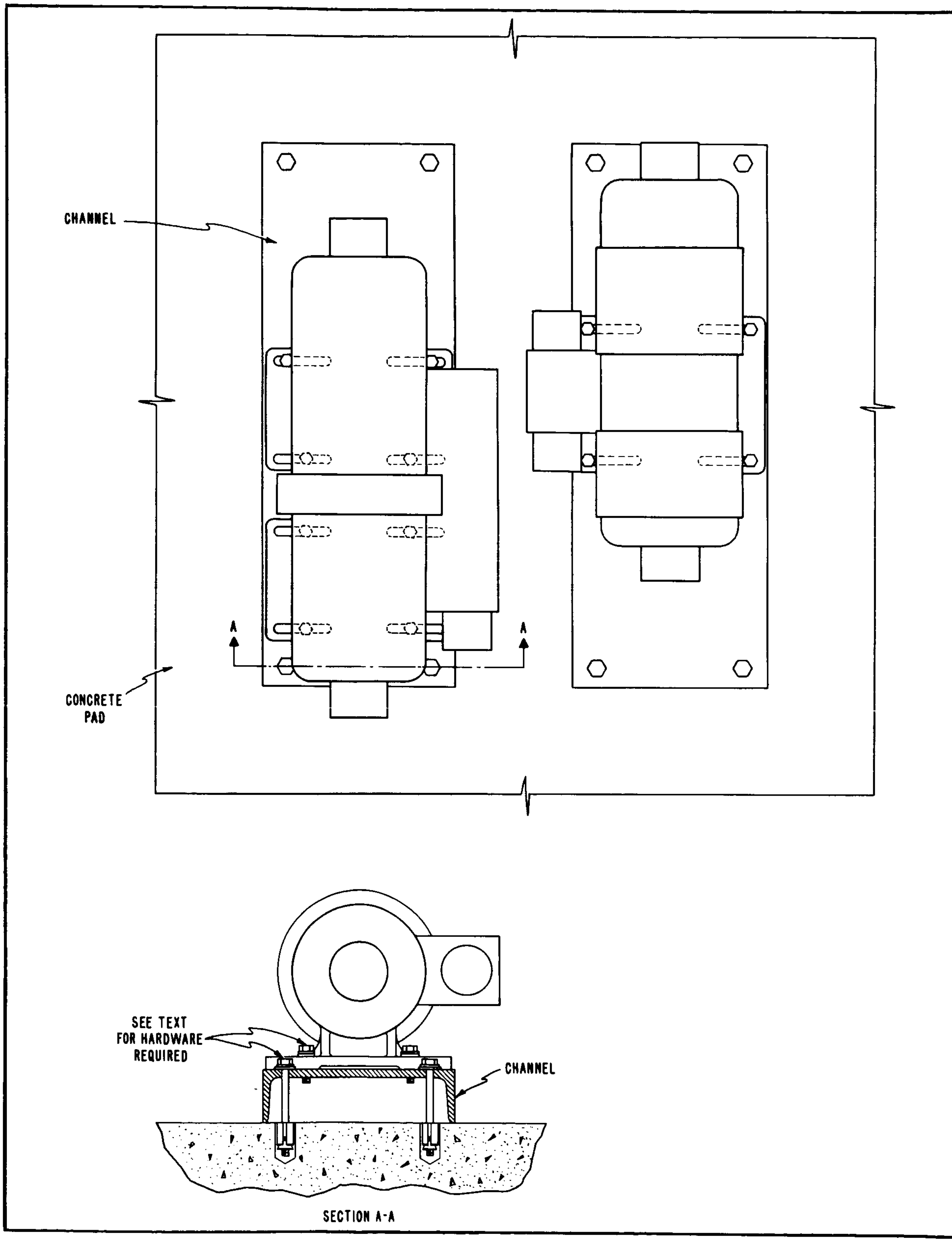


Figure 2-4. Amplidyne Installation

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE

Hardware Name and Description	Part Number	Qty.
ACQUISITION DATA CONSOLE AND ACTIVE ACQUISITION AID CONTROL CONSOLE (See figure 2-3(C).)		
Anchor bolt, 5/16" lead insert	A683322-1	6
Bolt, 5/16" - 18NC, 1" long	HK936S16-2018	6
Flat washer, 5/16"	HK779S20-A	6
Lock washer, 5/16"	HK779G20-E	6
ACTIVE ACQUISITION AID RECEIVER AND SERVO CABINETS (See figure 2-3(A).)		
Anchor bolt, 5/16" lead insert	A683322-1	4
Bolt, 5/16" - 18NC, 1" long	HK936S16-2018	4
Flat washer, 5/16"	HK779S20-A	4
Lock washer, 5/16"	HK779G20-E	4
ACTIVE ACQUISITION AID AZIMUTH AMPLIDYNE (See figures 2-3(B), 2-3(D), 2-4.)		
Mounting channel	N683369-1	1
Anchor bolt, 5/16" lead insert	A683322-1	4
Bolt, 5/16" - 18NC, 4-1/4" long	HK936S68-2018	4
Bolt, 5/16" - 18NC, 1-1/4" long	HK936S20-2018	8
Flat washer, 5/16"	HK779S20-A	12
Lock washer, 5/16"	HK779G20-E	12
ACTIVE ACQUISITION AID ELEVATION AMPLIDYNE (See figures 2-3(B), 2-3(D), 2-4.)		
Same as active acquisition aid azimuth amplidyne.		
ACTIVE ACQUISITION AID TRIPLEXER (See figure 2-5.)		
Support bracket	N653929-1	1
Bolt, 1/2" - 13NC, 1-1/4" long	HK936S20-3212	4
Nut, 1/2" - 13NC	HK775S32-13	4
Flat washer, 1/2"	HK779S32-A	4
Lock washer, 1/2"	HK799G32-M	4
Bolt, 3/8" - 16NC, 1-1/4" long	HK936S20-2416	4

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE (Cont.)

Hardware Name and Description	Part Number	Qty.
ACTIVE ACQUISITION AID TRIPLEXER (See figure 2-5.) (Cont.)		
Nut, 3/8" - 16NC	HK775S24-16	4
Flat washer, 3/8"	HK779S24-A	4
Lock washer, 3/8"	HK779G24-M	4
ACTIVE ACQUISITION AID DIPLEXERS (See figure 2-5.)		
Beam support	L683396-1	1
Clip angle	C683397-1	4
Mounting plate	N683395-1	1
Bolt, 3/8" 16NC, 1-1/4" long	HK936S20-2416	29
Nut, 3/8" 16NC	HK775S24-16	29
Flat washer, 3/8"	HK779S24-A	29
Lock washer, 3/8"	HK779G24-M	29
ACTIVE ACQUISITION AID RF HOUSING (See figure 2-5.)		
Mounting bracket	SK-1000-402	1
Bolt, 3/8" -16NC, 1-1/2" long	HK936S24-2416	3
Bolt, 3/8" -16NC, 1-1/4" long	HK936S20-2416	6
Nut, 3/8" 16NC	HK775S24-16	9
Flat washer, 3/8"	HK779S24-A	9
Lock washer, 3/8"	HK779G24-M	9
UHF VOICE PREAMPLIFIER (See figure 2-5.)		
Mounting plate	N683112-1	1
Bolt, 5/16" -18NC, 1-1/4" long	HK936S20-2018	4
Bolt, 5/16" -18NC, 7/8" long	HK936S14-2018	4
Nut, 5/16" -18NC	HK775S20-18	8
Flat washer, 5/16"	HK779S20-A	8
Lock washer, 5/16"	HK799G20-M	8
ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (See figure 2-5.)		
Binder head screw, 10-32, 7/8" long	HK950S28-1032	3

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE (Cont.)

Hardware Name and Description	Part Number	Qty.
ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (See figure 2-5.) (Cont.)		
Hex nut, 10-32	HK775S10-32	3
Lock washer, No. 10	HK799G10-M	3
ACTIVE ACQUISITION AID BORESIGHT TRANSMITTER (See figure 2-6.)		
Mounting channel	N689950-1	1
Bolt, 1/4" - 20NC, 3/4" long	HK936S12-1620	6
Flat washer, 1/4"	HK779S16-A	6
Lock washer, 1/4"	HK799G16-H	6
Bolt, 3/8" - 16NC, 7/8" long	HK936S14-2416	4
Nut, 3/8" - 16NC	HK775S24-16	4
Flat washer, 3/8"	HK779S24-A	4
Lock washer, 3/8"	HK799G24-H	4
ACTIVE ACQUISITION AID BORESIGHT ANTENNA (See figure 2-6.)		
Antenna Support	653792-1	1
Mounting plate	653751-2	1
Clamp	689834-1	2
Bolt, 3/8" -16NC, 1" long	HK936S16-2416	6
Nut, 3/8" - 16NC, 1" long	HK775S24-16	4
Lock washer, 3/8"	HK799G24-M	10

(2). RF HOUSING

The active acquisition aid RF housing is installed on the underside of the antenna tower platform in the location shown on figure 2-5. The unit is supported by a special bracket which is fastened to the tower platform. Refer to table 2-I for the installation hardware required.

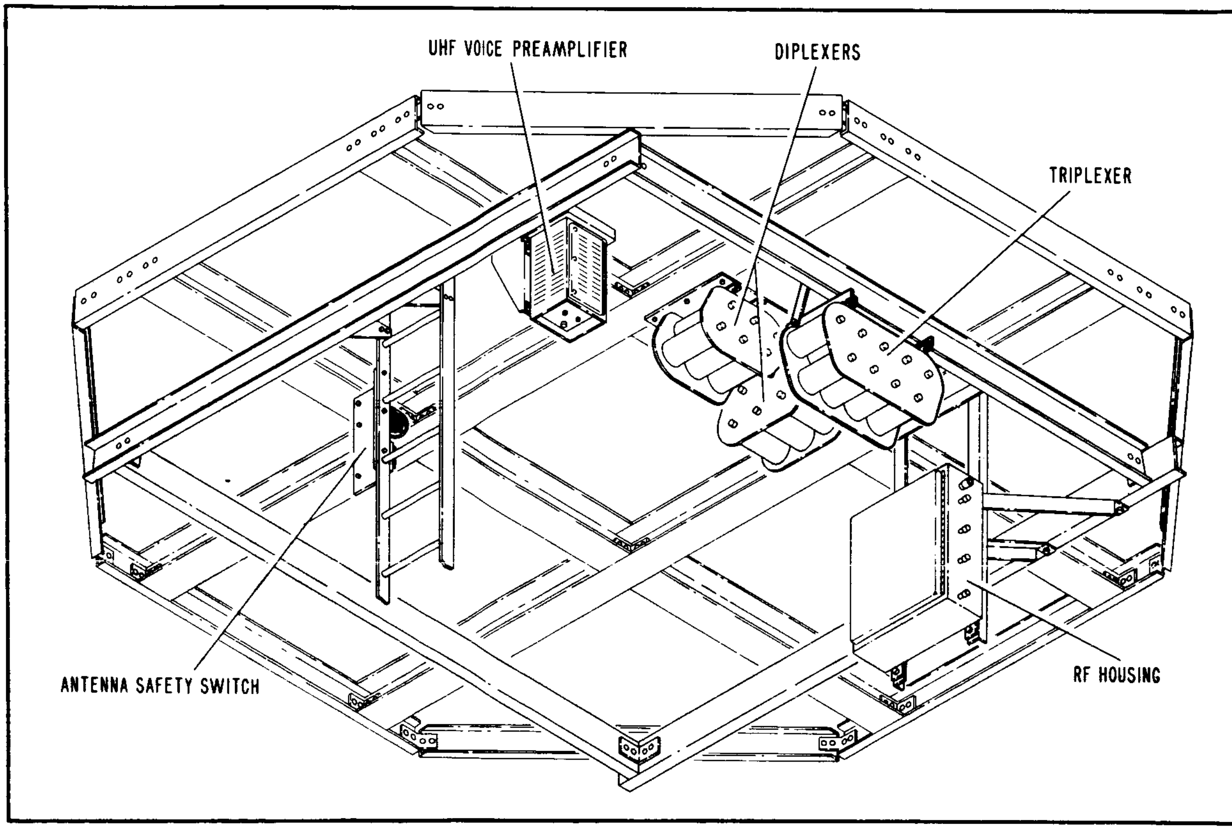


Figure 2-5. Active Acquisition Aid RF Equipment Installation

(3). MULTIPLEXERS

The active acquisition aid multiplexers (triplexer and two diplexers) are mounted underneath the antenna tower platform. The triplexer is fastened to a bracket, and the two diplexers are fastened to a common mounting plate. See figure 2-5 for the location of these components, and refer to table 2-I for the installation hardware required.

(4). UHF VOICE PREAMPLIFIER

The UHF voice preamplifier, which is part of the capsule communications system, is installed with the active acquisition aid equipment on the underside of the active acquisition aid antenna tower. (See figure 2-5.) It is supported by a special mounting bracket. Refer to table 2-I for the installation hardware required.

(5). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted near the top of one of the ladders leading to the top of the active acquisition aid antenna platform. The required hardware is listed in table 2-I. See figure 2-5.

(6). BORESIGHT TRANSMITTER AND ANTENNA

The active acquisition aid boresight transmitter and antenna are mounted on the boresight antenna tower; the transmitter on a bracket near the base of the tower, and the antenna on the top of the tower. The bracket which supports the transmitter; the special support, mounting plate, and two clamps which mount the boresight antenna; and the hardware required for installation are listed in table 2-1. Details of the installation are shown on figure 2-6.

C. SMALL COMPONENTS

(1). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

(a). The synchro reference voltage step-down transformers for the receiving and transmitting antennas are located in the servo racks for these antennas. See figure 2-7. The transformer in each rack is mounted behind the second panel from the bottom of the rack.

(b). The synchro reference voltage transformer for the Verlort radar is installed on the floor in the corner of the van behind the auxiliary console (figure 1-19).

(c). In the FPS-16 radar building the synchro reference voltage transformer is located on top of the radar data switch unit. See figure 1-20 for the location of the synchro reference transformer.

(d). The synchro reference voltage transformer for the PMR van is mounted in the transmitter van cable termination box.

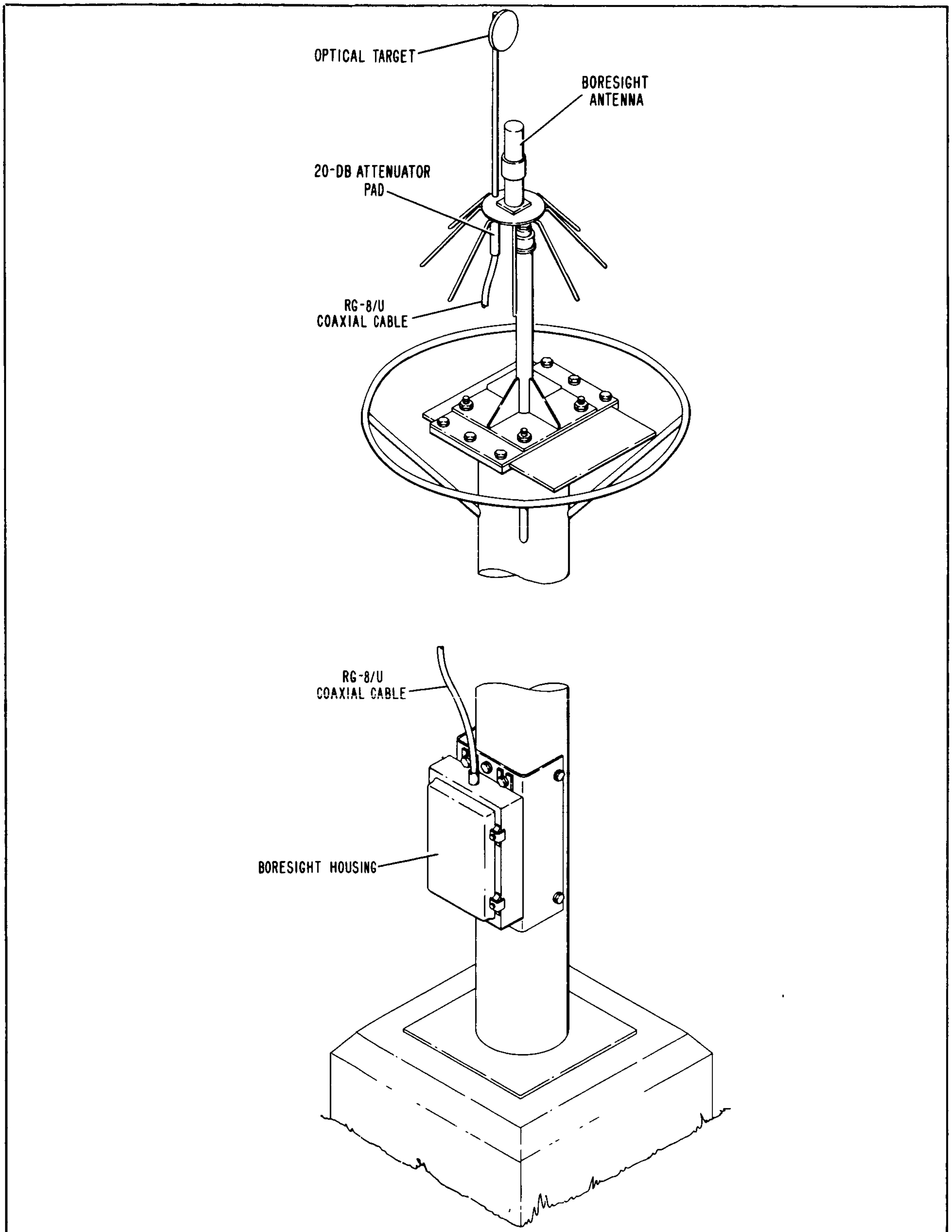


Figure 2-6. Active Acquisition Aid Boresight Transmitter and Antenna Installation

(e). The active acquisition aid obtains its synchro reference voltage from the acquisition data console. Therefore, there is no reference voltage transformer associated with the active acquisition aid. The reference voltage transformer for the acquisition data console is supplied as part of the console and requires no separate installation.

(2). SYNCHRO LINE AMPLIFIER

(a). The synchro line amplifier in the transmitter van is mounted in the servo cabinet (figure 1-18).

(b). The synchro line amplifier in the Verlort radar is mounted in the Sanborn recorder (figure 1-19).

(c). The synchro line amplifier in the FPS-16 building is housed in a separate small cabinet which sits next to the data switch unit (figure 1-20).

(3). RADAR CONTROL RELAYS

The Verlort radar control relay (on the master-slave relay panel) is installed as shown in figure 1-19 in the back of the Verlort van.

The FPS-16 radar control relay is furnished as part of the FPS-16 radar data switch unit and requires no separate installation. For information on the data switch unit, refer to the RADAR TRACKING SYSTEM MANUAL, MS-101.

2-3. INTERCONNECTING CABLING

A. ELECTRICAL INTERCONNECTIONS

An acquisition system interconnecting cabling diagram is included in Section VII. (figure 7-22). This diagram shows all of the interconnections within the acquisition system and the interconnections between the acquisition system and equipment of other systems. Detailed interconnecting wiring information is not included in this manual. It is provided in a separate book, as a "Installation Wiring Information" chart, part number L683173-15. The Verlort radar cable termination box interconnecting wiring information is provided in Radar Tracking System Manual, MS-101. Interconnecting wiring information for the transmitter van cable termination box is provided in the Capsule Communications System Manual, MS-102.

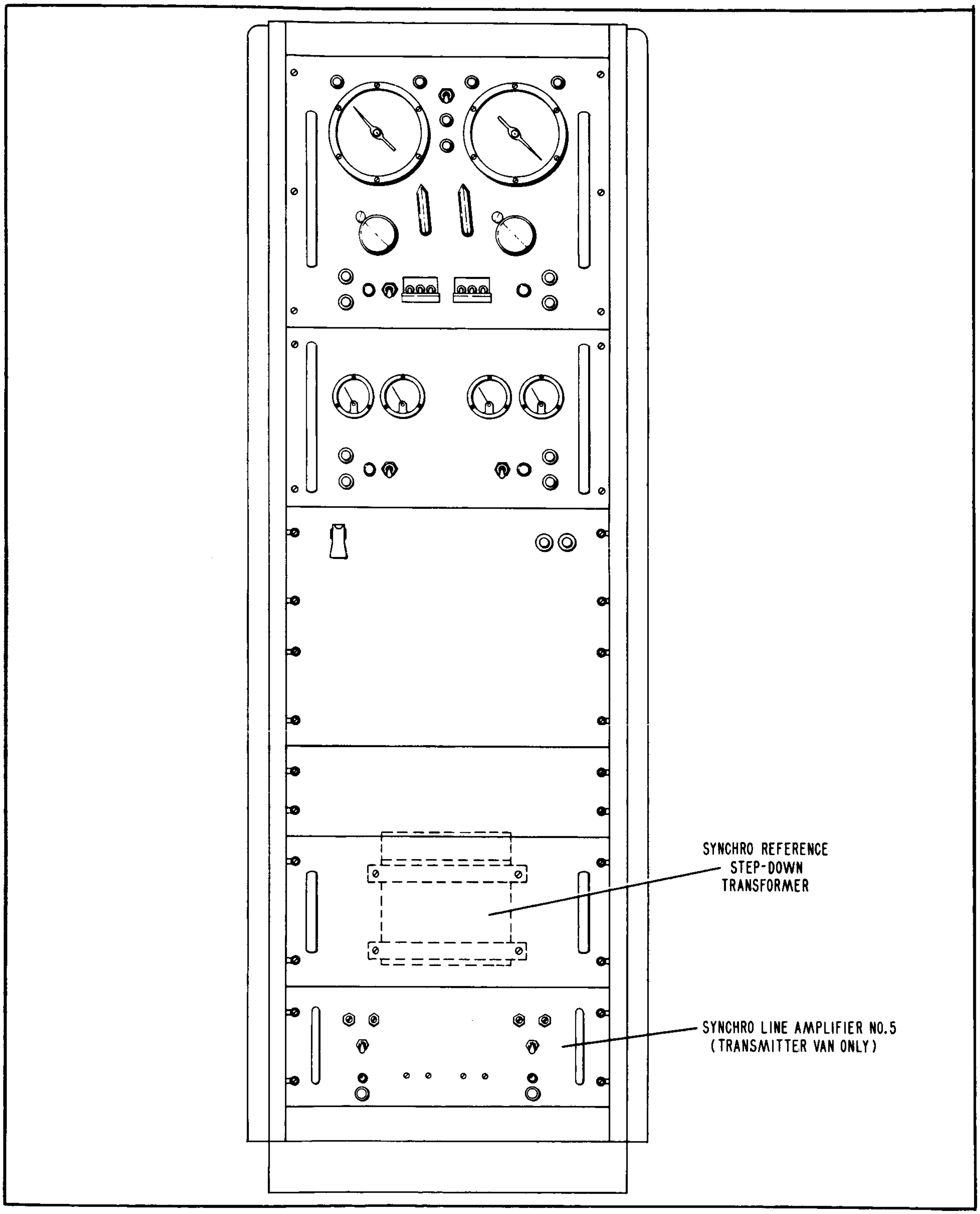


Figure 2-7. Location of Synchro Reference Voltage Step-down Transformer and Synchro Line Amplifier in Antenna Servo Rack

B. CABLE INSTALLATION

The physical installation of equipment interconnecting cabling is not covered in this manual. It is included in the installation wiring information chart (refer to the previous paragraph) and provided directly to the site on separate drawing.

2-4. PRE-OPERATIONAL CHECKS

A. COMPONENT (UNIT) CHECKS

Pre-operational checks of the components of the acquisition system other than the acquisition data console are given in the individual equipment manuals. Pre-operational checks for the acquisition data console are described in Section III of this manual.

B. SYSTEM CHECKS

No pre-operational checks are required for the overall acquisition system. Operational system checks are described in Section III. It should be kept in mind that any malfunctions involving synchros which occur the first time the system checks are run are likely to be caused by incorrect interconnecting wiring of the synchro circuits. Refer to Section V and particularly to figure 5-1 for information on trouble shooting synchro circuit malfunctions.

SECTION III
SYSTEM OPERATION

3-1. GENERAL

A. This section contains a tabulation (table 3-I) and illustrations of the controls on the acquisition data console, initial and normal turn-on procedures for system equipment, system operational checks, and normal and emergency system operating procedures. Complete, detailed procedures are included for the acquisition data console only since detailed procedures for other system equipment are in the various equipment manuals (listed in table 1-II).

B. For proper operation of the acquisition system, it is necessary that all operators involved, and particularly the acquisition data console operator, have a thorough knowledge and understanding of the makeup, capabilities, and limitations of the overall system and the equipment connected to it. Refer to Sections I and IV of this manual.

3-2. INITIAL TURN-ON PROCEDURE

The procedure described in this paragraph is to be followed the first time the equipment is turned on after installation or major repair. For initial turn-on procedures for equipment other than the acquisition data console, see the applicable equipment manuals. Proceed as follows for the acquisition data console.

A. EXTERNAL POWER CONNECTIONS

(1). With the acquisition data console circuit breaker on the site power panel turned on, check to see that 115 VAC is applied to console terminal board TB6001, terminals 1 and 2.

(2). Check to see that approximately 480 VAC is applied to the console on TB6001-7 and -8.

(3). Check the secondary voltage of transformer T6001. It should be between 115 and 120 VAC. If this voltage is less than 115 VAC, move the lead connected to terminal 4 of the transformer to terminal 5.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS

Name	Function
ACQUISITION DATA PANEL NO. 1 (See Figure 3-1.)	
"28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 2 and indicates whether it is operating properly.
"28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 1 and indicates whether it is operating properly.
"NO DATA ON BUS" INDICATOR	Indicates that none of the "SOURCE" switches has been depressed.
VERLORT RADAR "SOURCE" SWITCH	Connects data from the Verlort to the acquisition bus.
VERLORT RADAR MODE INDICATORS	Indicate whether the Verlort radar is in automatic tracking, slaved or manual mode of operation.
ACTIVE ACQUISITION AID "SOURCE" SWITCH	Connects data from the active acquisition aid to the acquisition bus.
ACTIVE ACQUISITION AID MODE INDICATORS	Indicate whether the active acquisition aid is in automatic tracking, slaved, or manual mode of operation.
ACTIVE ACQUISITION AID "CABLE WRAP" INDICATORS	Indicate whether the active acquisition aid antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
ACTIVE ACQUISITION AID "AZIMUTH" DISPLAY	Shows the azimuth angle of the active acquisition aid antenna.
ACTIVE ACQUISITION AID "ELEVATION" DISPLAY	Shows the elevation angle of the active acquisition aid antenna.
VERLORT RADAR "AZIMUTH" DISPLAY	Shows the azimuth angle of the Verlort antenna.
VERLORT RADAR "ELEVATION" DISPLAY	Shows the elevation angle of the Verlort antenna.
FPS-16 RADAR "AZIMUTH" DISPLAY	Shows the azimuth angle of the FPS-16 radar.
FPS-16 RADAR "ELEVATION" DISPLAY	Shows the elevation angle of the FPS-16 antenna.
FPS-16 RADAR MODE INDICATORS	Indicate whether the FPS-16 radar is in automatic tracking, slaved, or manual mode of operation.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
ACQUISITION DATA PANEL NO. 1 (See Figure 3-1.) (Cont.)	
FPS-16 RADAR "SOURCE" SWITCH	Connects data from the FPS-16 to the acquisition bus.
MANUAL INPUT "AZIMUTH" DISPLAY	Shows angle to which the azimuth manual input transmitter has been turned.
AZIMUTH "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the azimuth manual input transmitter.
MANUAL INPUT "SOURCE" SWITCH	Connects data from the manual input transmitters to the acquisition bus.
ELEVATION "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the elevation manual input transmitter.
MANUAL INPUT "ELEVATION" DISPLAY	Shows angle to which the elevation manual input transmitter has been turned.
ACQUISITION DATA PANEL NO. 2 (See Figure 3-2.)	
RCVR ANT MODE INDICATORS	Indicate whether the receiving antenna is in slaved or manual mode of operation.
RCVR ANT "ELEVATION" DISPLAY	Shows the elevation angle of the receiving antenna.
RCVR ANT "CABLE WRAP" INDICATORS	Indicate whether the receiving antenna is clockwise or counterclockwise from the mid-point of its 540° azimuth travel.
RCVR ANT "AZIMUTH" DISPLAY	Shows the azimuth angle of the receiving antenna.
XMTR ANT "CABLE WRAP" INDICATORS	Indicate whether transmitting antenna is clockwise or counterclockwise from the mid-point of its 540° azimuth travel.
XMTR ANT "AZIMUTH" DISPLAY	Shows the azimuth angle of transmitting antenna.
XMTR ANT "ELEVATION" DISPLAY	Shows the elevation angle of transmitting antenna.
XMTR ANT MODE INDICATORS	Indicate whether transmitting antenna is in the slaved or manual mode of operation.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
DUAL POWER SUPPLY (See Figure 3-3.)	
OFF-ON SWITCH	Controls application of primary power to the dual power supply.
FUSES	Contain primary power line fuses and indicators to show when a fuse is blown.
POWER-ON INDICATOR	Indicates the application of primary power to the dual power supply.
SYNCHRO LINE AMPLIFIER (See Figure 3-4)	
CHANNEL "OFF-ON SWITCHES"	Each applies power to one amplifier channel.
CHANNEL LINE "COMPENSATION" CONTROLS	Each pair adjusts the gain and balance of one amplifier channel.
CHANNEL "2 AMP" FUSES	Primary power line fuses - one for each channel.
CHANNEL "POWER" ON INDICATORS	Indicate that channel primary power has been turned on.
INTERCOM PANEL (See Figure 3-5.)	
Refer to Intrasite PBX and Intercom System Manual, MS-109.	
ACTIVE ACQUISITION AID CONTROL CONSOLE SIGNAL STRENGTH METER PANEL (See Figure 3-6.)	
RCVR ANT. FREQ. A TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to receiving antenna.
AAA, ANT. FREQ. A TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to active acquisition aid antenna.
RCVR ANT. FREQ. B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to the receiving antenna.
AAA ANT. FREQ. B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to active acquisition aid antenna.
CALIBRATION CONTROLS	Permit calibration of the meters to read actual signal strength.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
ACTIVE ACQUISITION AID CONTROL CONSOLE SIGNAL STRENGTH METER PANEL (See Figure 3-6.) (Cont.)	
PILOT LAMPS	Correlate audio signal source with signal strength indication.
ACTIVE ACQUISITION AID METER AND SWITCH PANEL (Note 1) (See Figure 3-7.)	
"SIGNAL STRENGTH" METER	Indicates strength of signal at active acquisition aid receiver.
PILOT LAMP	Correlates audio signal source with signal strength indication.
"SELECTOR" SWITCH	Selects one of five sources of audio signal for monitoring and applies 28 VDC to pilot lamp adjacent to signal strength meter which is connected to the audio source selected.
"VOLUME" CONTROL	Adjusts volume of audio signal being monitored.

Notes: 1. For a description of the two error meters on the meter and switch panel and for all other controls, indicators, and displays on the active acquisition aid, refer to the active acquisition aid equipment manual.

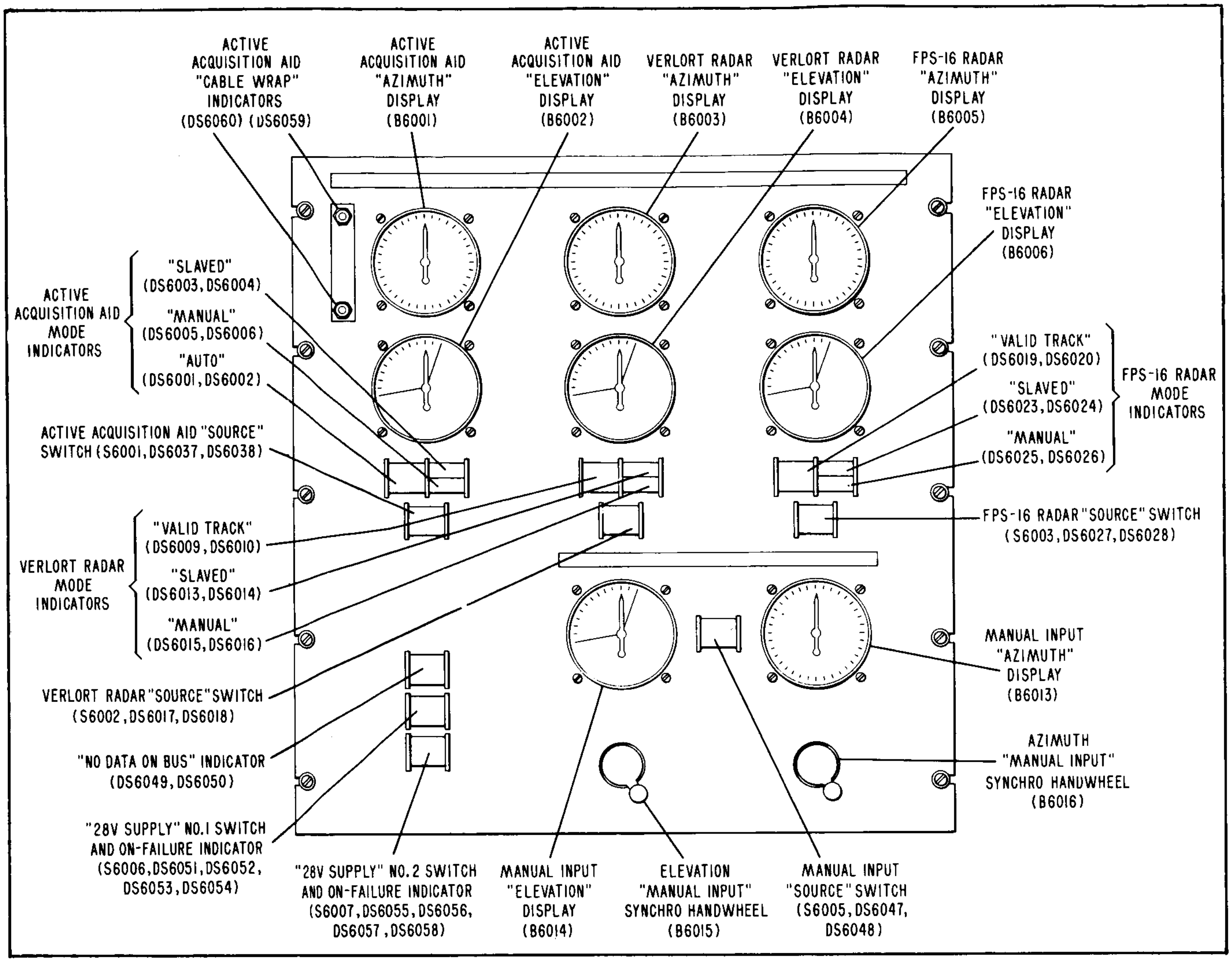


Figure 3-1. Acquisition Data Panel No. 1

B. <u>28 VDC POWER SUPPLY</u>

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 switch on the acquisition data panel (figure 3-1). This action turns on power supply number 1. The on-failure indicator for power supply number 1 should be green and the indicator for power supply number 2 should be red.

(4). Remove the display screens from both of the on-failure indicators. Check to see that all color filters are in place (two red and two green in each indicator). The two lamps in the power supply number 1 indicator with green color filters should be lit, and the two lamps in the power supply number 2 indicator with red color filters should be lit.

(5). Check and, if necessary, adjust the output voltage of power supply number 1 in accordance with the instructions in paragraph 5-4.D.(2).

(6). Turn off power supply number 1 by turning off the OFF-ON switch on the dual power supply panel.

Note

Due to the long time constant of the power supply filter, several seconds are required after turning off the power supply before the holding coil of the "28V SUPPLY" switch releases.

(7). Turn on the OFF-ON switch on the dual power supply panel.

(8). Depress the "28V SUPPLY" number 2 switch on the acquisition data panel. This action turns on power supply number 2. The on-failure indicator for power supply number 2 should be green and the indicator for power supply number 1 should be red.

(9). Check the indicators of both power supplies to see that both of the lamps with green color filters in power supply number 2 indicator are lit and that both of the lamps with the red color filters in the power supply number 1 indicator are lit.

(10). Check and, if necessary, adjust the output voltage of power supply number 2 in accordance with the instructions in paragraph 5-4.D.(2).

(11). Depress the "28V SUPPLY" number 1 switch. The on-failure indicators for both power supplies should be green.

C. INDICATORS

(1). Turn on the acquisition data console circuit breaker on the site power panel.

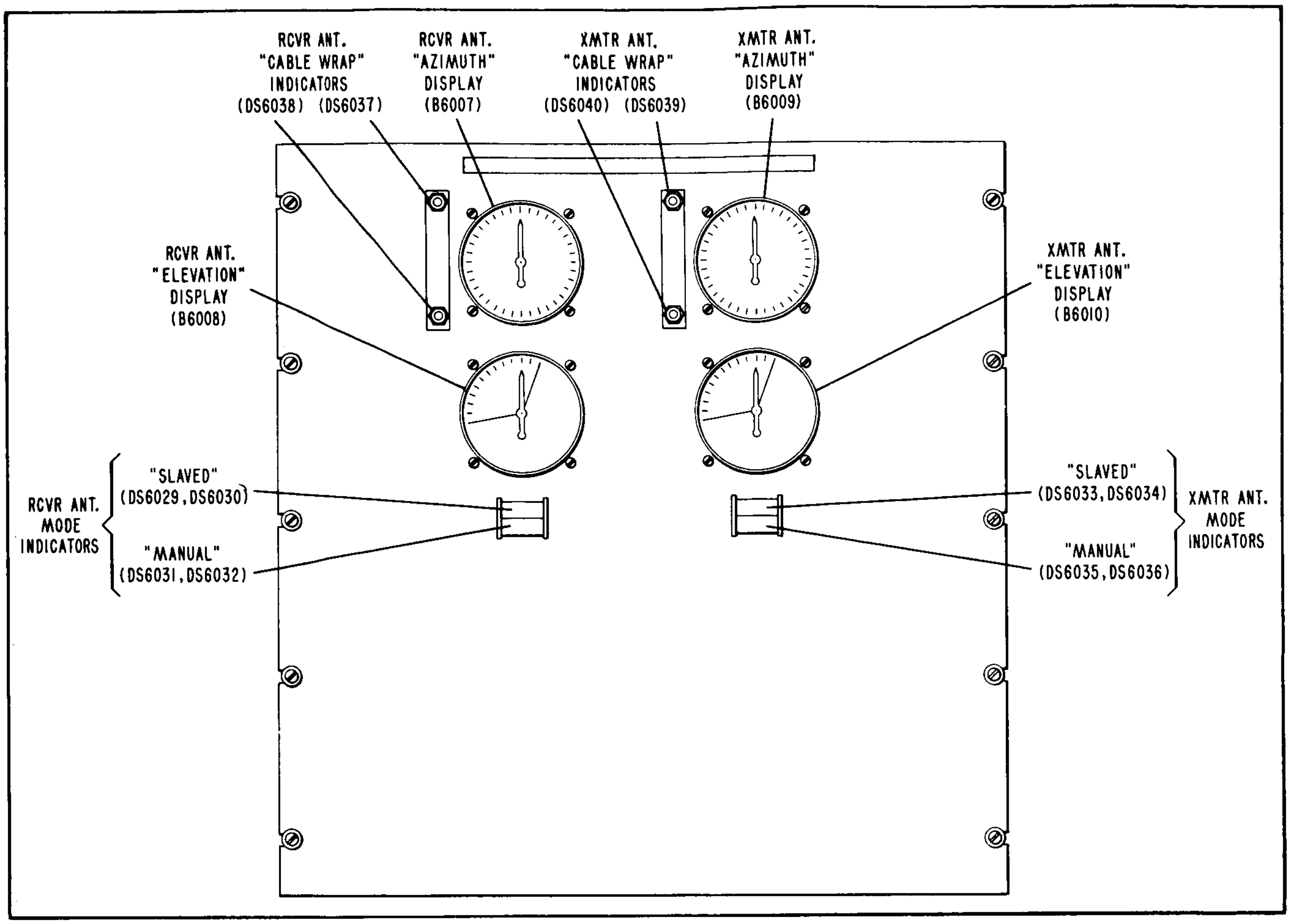


Figure 3-2. Acquisition Data Panel No. 2

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel (figure 3-1).

(4). Check the operation of each of the console indicators by completing its circuit with a temporary jumper to a 28 VDC source or ground. The indicators to be checked in this manner and the associated terminals to be jumpered to 28 VDC or ground are listed in table 3-II. As each of the indicators is lighted, remove its display screen to see that both color filters are in place and that both lamps are working (except for the cable wrap indicators, which have no color filter and only one lamp).

D. <u>SOURCE SWITCHES (Figure 3-1)</u>

(1). Turn on the acquisition data console circuit breaker on the site power panel.

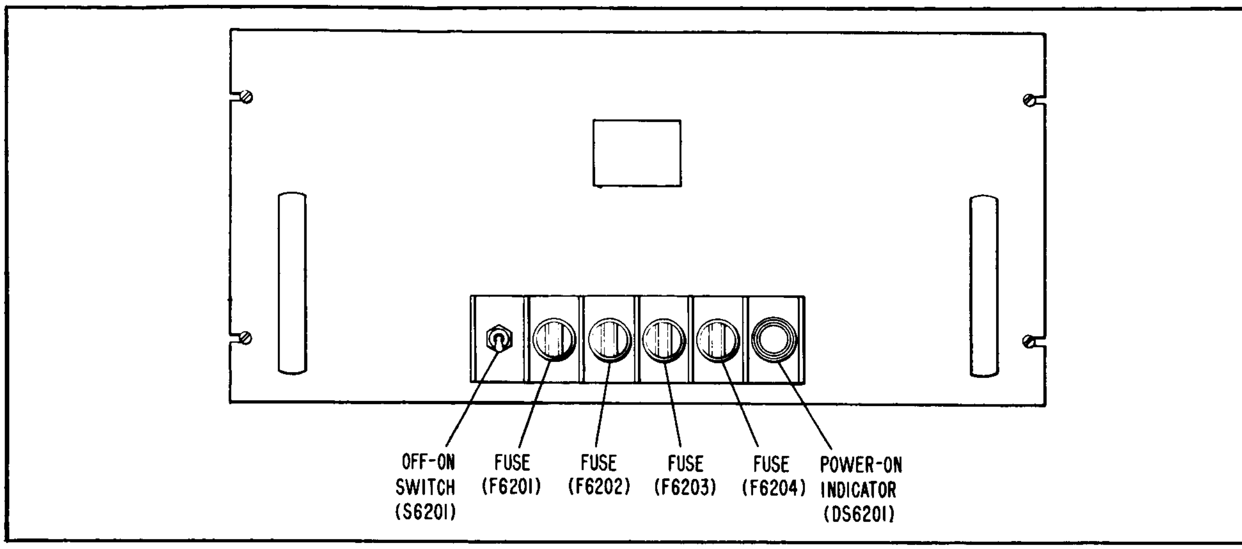


Figure 3-3. Dual Power Supply

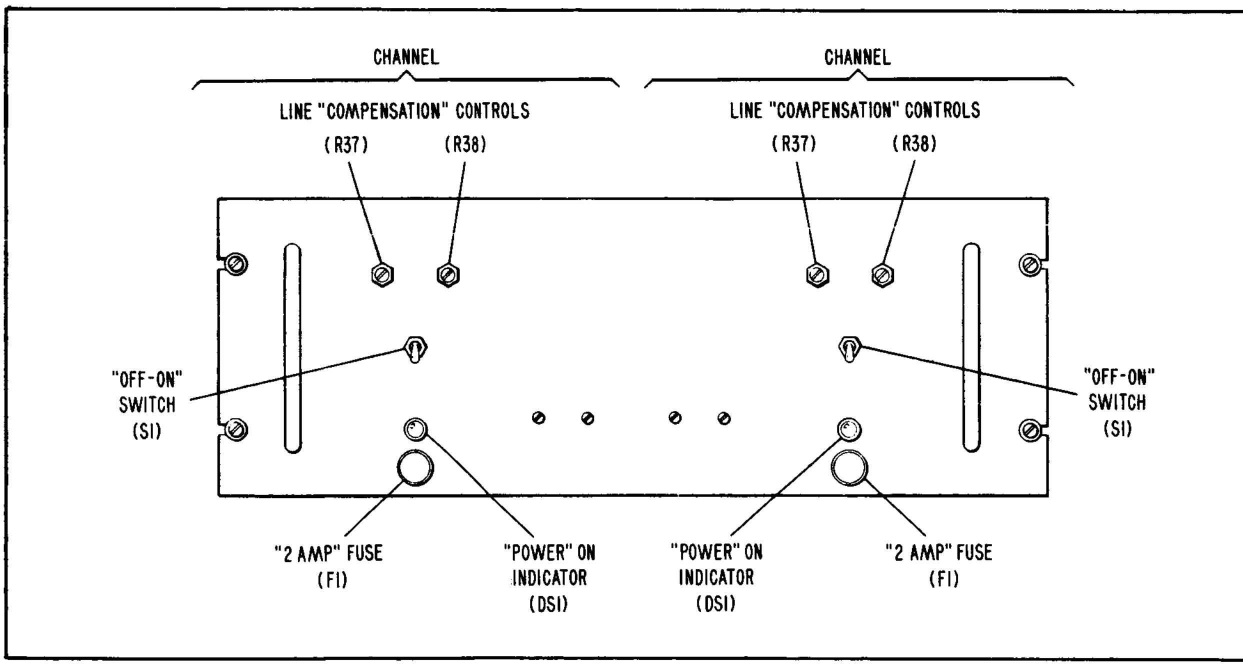


Figure 3-4. Synchro Line Amplifier

(2). Turn on the OFF-ON switch on the dual power supply panel and depress "28V SUPPLY" number1 and number 2 switches on acquisition data panel number 1.

(3). The "NO DATA ON BUS" indicator should be lit. Remove the display screen and check that both color filters are in place and that both lamps are lit.

TABLE 3-II. INDICATOR CHECKOUT PROCEDURE

Indicator	Terminal to be Jumpered	Jumper Connection
Active Acquisition Aid "CABLE WRAP" (DS6059)	TB6008-5	28 VDC
Active Acquisition Aid "CABLE WRAP" (DS6060)	TB6008-6	28 VDC
Active Acquisition Aid "AUTO" (DS6001, DS6002)	TB6008-1	28 VDC
Active Acquisition Aid "SLAVED" (DS6003, DS6004)	TB6008-1	28 VDC
Active Acquisition Aid "MANUAL" (DS6005, DS6006)	TB6008-3	Ground
Verlort Radar "VALID TRACK" (DS6009, DS6010)	TB6010-1	Ground
Verlort Radar "SLAVED" (DS6013, DS6014)	TB6010-2	28 VDC
Verlort Radar "MANUAL" (DS6015, DS6016)	TB6010-3	28 VDC
FPS-16 Radar "VALID TRACK" (DS6019, DS6020)	TB6010-5	Ground
FPS-16 Radar "SLAVED" (DS6023, DS6024)	TB6010-6	28 VDC
FPS-16 Radar "MANUAL" (DS6025, DS6026)	TB6010-7	28 VDC
Receiving Antenna "CABLE WRAP" (DS6037)	TB6021-3	28 VDC
Receiving Antenna "CABLE WRAP" (DS6038)	TB6021-4	28 VDC
Receiving Antenna "SLAVED" (DS6029, DS6030)	TB6021-1	28 VDC
Receiving Antenna "MANUAL" (DS6031, DS6032)	TB6021-2	28 VDC
Transmitting Antenna "CABLE WRAP" (DS6039)	TB6022-3	28 VDC
Transmitting Antenna, "CABLE WRAP" (DS6040)	TB6022-4	28 VDC
Transmitting Antenna "SLAVED" (DS6033, DS6034)	TB6022-1	28 VDC
Transmitting Antenna "MANUAL" (DS6035, DS6036)	TB6022-2	28 VDC

(4). Depress the manual input "SOURCE" switch. The "NO DATA ON BUS" indicator lamp should go out. The switch should remain depressed, and its indicator lamps should light. Check the color filters and lamps with the display screen removed.

(5). Depress the active acquisition aid "SOURCE" switch. The manual input "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The active acquisition aid "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(6). Depress the Verlort radar "SOURCE" switch. The active acquisition aid "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The Verlort radar "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(7). Depress the FPS-16 radar "SOURCE" switch. The Verlort radar "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The FPS-16 radar "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

E. SYNCHROS AND SYNCHRO LINE AMPLIFIER

There is no convenient means of performing checks on the synchros and synchro line amplifier without operation of the entire acquisition system and all of the equipment connected to it. Therefore, the initial check of these items should be made during the first system operational check (paragraph 3-5).

F. SIGNAL STRENGTH METERS AND PILOT LAMPS

As part of the initial turn-on procedure, the meters on the active acquisition aid control console signal strength meter panel (figure 3-6) require calibration. Refer to paragraph 5-4. H. for detailed instructions. Proceed as follows to check the operation of the pilot lights on the meter panel:

(1). With the active acquisition aid energized, turn "SELECTOR" switch S62301 on the meter and switch panel to the number 1 position. Pilot lamp DS62301 (beneath the "SIGNAL STRENGTH" meter M62303 on the meter and switch panel) should light. See figure 3-7.

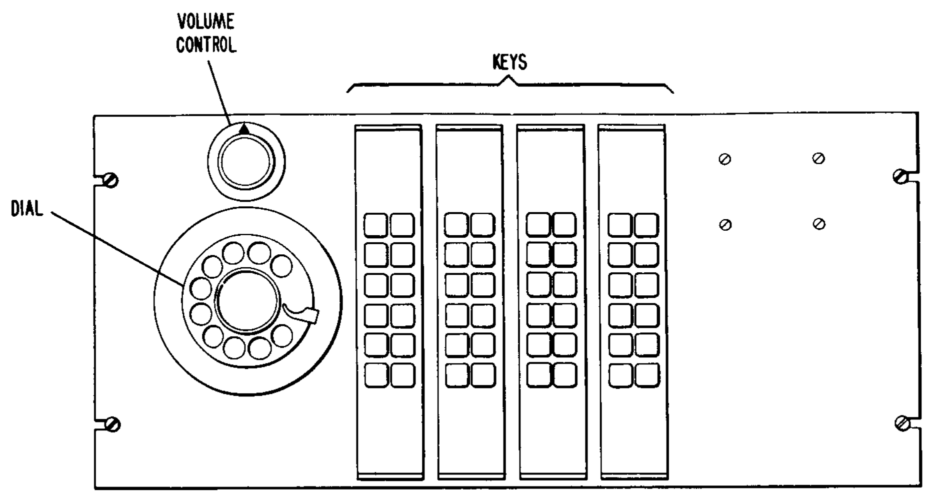


Figure 3-5. Intercom Panel

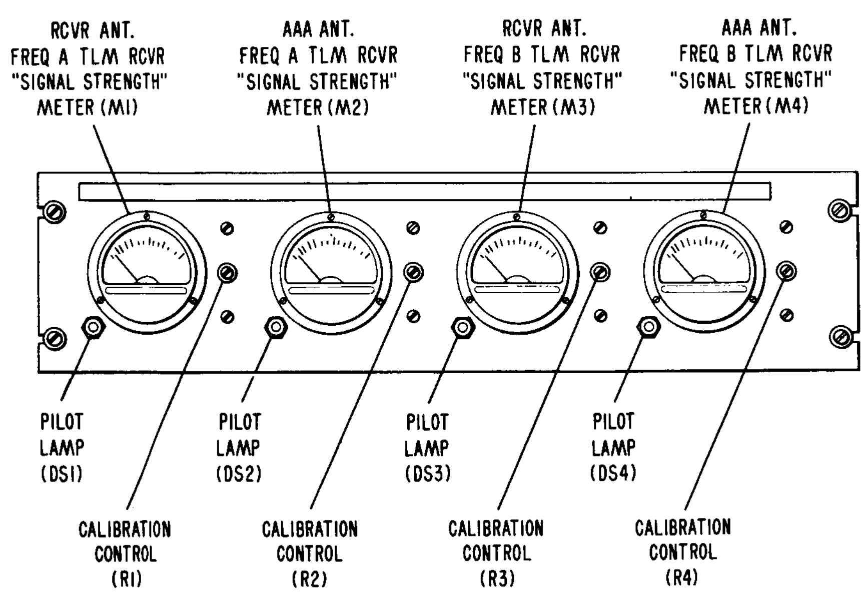


Figure 3-6. Active Acquisition Aid Control Console Signal Strength Meter Panel

(2). Turn "SELECTOR" switch S623-1 to positions 2, 3, 4 and 5. Pilot lamp DS1, DS2, DS3 and DS4 on the signal strength meter panel should light in succession. See figure 3-6.

G. INTERCOM PANEL

For information on the intercom panel, refer to the Intrasite PBX and Intercom System Manual, MS-109.

3-3. NORMAL TURN-ON PROCEDURE

A. For normal turn-on procedures for all equipment other than the acquisition data console, see the applicable equipment manuals.

B. For normal turn-on of the acquisition data console, proceed as follows:

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches (figure 3-1). Both of the associated indicators should come on and should be green. The acquisition data console is now ready for operation.

3-4. NORMAL OPERATING PROCEDURE

Paragraph 3-4.A. presents operating instructions for the acquisition system without specifying when and under what conditions the various functions are to be performed. The latter information is given in paragraph 3-4.B.

A. OPERATING INSTRUCTIONS

(1). Turn on the acquisition data console in accordance with paragraph 3-3.

(2). Turn on each of the synchro line amplifiers on the acquisition data console by turning on all of the channel "OFF-ON" switches. The "POWER ON" indicators should come on. (See figure 3-4.)

(3). By intercom, instruct the transmitting antenna and radar operators to turn on their synchro line amplifiers.

(4). If the manual input is to be used, set the handwheels (figure 3-1) so that the associated displays are at the desired azimuth and elevation.

(5). By intercom, instruct the operators of the receiving antenna, the transmitting antenna, the active acquisition aid, and the radars to disconnect their equipment from the acquisition bus and stand by for further instructions.

(6). Check the d-c mode indications (figure 3-2) from the receiving antenna and the transmitting antenna to see that the antennas are in the manual local input) mode of operation. The active acquisition aid and the radars should be in the manual or automatic mode.

CAUTION

The purpose of disconnecting equipment from the acquisition bus before switching data on is to avoid sudden, large changes in the inputs to the antenna positioning systems. Such step-function inputs impose unnecessary wear on the equipment, and under certain circumstances can drive the antennas into their azimuth or elevation limit stops.

(7). Connect the desired source of data (manual, active acquisition aid, Verlort, or FPS-16) to the acquisition bus by depressing the proper "SOURCE" switch (figure 3-1). The source switch indicator should light and the switch should remain depressed after being released. The "NO DATA ON BUS" indicator should go out.

(8). By intercom, instruct the operators of all antennas which are not the source of the data on the bus to set their antennas to the approximate azimuth and elevation which have been connected to the bus. The azimuth and elevation data connected to the bus is shown on the console displays of the selected source (figure 3-1).

(9). Check the position of the antennas on the console displays and then instruct the operators that they may slave their antennas to the acquisition bus. (Table 3-III gives the name, location, and proper position or condition of the various controls used for selecting the operating modes of the various pieces of equipment in or connected to the acquisition system.)

CAUTION

Be sure that the positions of the active acquisition aid, receiving, and transmitting antennas are correct before they are slaved to the acquisition bus. Otherwise, one or more of them may be driven into its azimuth or elevation limit stops.

TABLE 3-III. MODE INDICATING CONTROLS

Equipment	Mode	Name of Control	Location	Position for Mode Operation
Active Acquisition Aid	Manual	"MANUAL" switch	Control Console Mode Switch Panel	Depressed
	Automatic	"AUTO" switch	Control Console Mode Switch Panel	Depressed
	Slaved	"SLAVED" switch	Control Console Mode Switch Panel	Depressed
Receiving Antenna	Manual	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
	Slaved (Note 1)	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
Transmitting Antenna	Manual	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
	Slaved (Note 1)	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
FPS-16 Radar	Manual	"MANUAL MODE" pushbutton	Range Indicator Panel, Radar Console	Depressed
	Automatic	"DATA ACCEPTABLE-YES" pushbutton	Radar Indicator Panel, Radar Console	Depressed
	Slaved	"DESIGNATION DATA SOURCE 1" pushbutton	Range Indicator Panel, Radar Console	Depressed

TABLE 3-III. MODE INDICATING CONTROLS (Cont.)

Equipment	Mode	Name of Control	Location	Position for Mode Operation
Verlort Radar	Manual	"MANUAL" pushbutton	Mode Control Panel, Radar Console	Depressed
	Automatic	"DATA ACCEPTABLE" switch	Range and Aided Control Panel, Radar Console	"ON"
	Slaved	"REMOTE POSITION SELECTOR" switch	Mode Control Panel, Radar Console	Position "3"
		"REMOTE" pushbutton	Mode Control Panel, Radar Console	Depressed

Notes: 1. For a "SLAVED" indication on the acquisition data console, both switches must be in the remote position. Otherwise, a "MANUAL" indication is given.

(10). Check the d-c mode indicators to see that the transmitting and receiving antennas are slaved to the acquisition bus. If the active acquisition aid or one of the radars has been selected as the source of data for the acquisition bus, it cannot be slaved to the bus. Otherwise, slaving of the active acquisition aid to the bus is at the option of the active acquisition aid operator, and slaving of the radars to the bus is at the option of the radar operators.

(11). Check the console displays of the slaved antennas to see that each of them is in the proper location in regard to its cable wrap limits. The upper "CABLE WRAP" indicator should be lit if the pointer of the associated "AZIMUTH" display is in the upper half of the dial, and the lower indicator should be lit if the pointer is in the bottom half of the dial. (Refer to paragraph 4-2.B.(4). and figure 4-7 for complete information on antenna position relative to cable wrap limits.)

(12). Check the system slaving accuracy: The console displays of data from slaved active acquisition aid and radar antennas should not differ by more than 1.5 degrees from the console displays of data from the selected source; displays from the receiving and transmitting antennas should not differ by more than 3.0 degrees.

(13). To change from one source of acquisition bus data to another, proceed as follows:

(a). Check the azimuth displays of the two data sources (the one to switched off the bus and the one to be switched onto the bus) to see that switching from one to the other will not drive the slaved antennas into their limit stops. Synchro devices and servo systems using them always turn in the direction which results in the lesser amount of rotation in turning to a new, switched-in position; when a synchro reeeiver is switched to a transmitter with a position different from that of the receiver, the receiver always turns 180 degrees or less—never more than 180 degrees. Thus, if a limit lies between the positions of the slaved antennas and the new source in the direction of lesser rotation, switching to the new source will drive the slaved antennas into their limits. When this circumstance exists, follow the procedure below before switching:

1. If manual input data is to be switched onto the bus (data from the active acquisition aid or one of the radars is on the bus and is to be switched off): Turn the manual input to approximately the same position as the data already on the bus.

2. If active acquisition aid or radar data is to be switched onto the bus (manual input data is on the bus and is to be switched off): Turn the manual input (and the antennas slaved to it) to the approximate position of the new source (active acquisition aid or one of the radars). If the new source is the active acquisition aid, turn the manual input in the direction which results in the slaved antennas being in the same position relative to their cable wrap limits as is the active acquisition aid antenna.

3. If data from the active acquisition aid, the Verlort, or the FPS-16, is on the bus, and data from another one of these sources is to be connected to the bus, connect the manual input to the bus in accordance with step 1. above. Then turn the manual input to the new source in accordance with step 2. This procedure brings the slaved antennas smoothly from the position of the old source to that of the new source without

having to change the position of either source.

(b). Connect the new source of data to the acquisition bus by depressing the appropriate "SOURCE" switch. This action also disconnects the previous source.

(c). If manual data has been switched onto the bus, but the manual input has been turned away from the desired position per step (a).1., set the manual input to the desired position.

(d). Check the condition of cable wrap and system slaving accuracy as directed in preceding steps (11) and (12).

B. OPERATING CRITERIA

The preceding paragraph has described how to perform various functions in the operation of the acquisition system. This paragraph describes when and under what conditions the functions are to be performed.

(1). PREPARATION FOR CAPSULE PASS

(a). Perform the system operational checks described in paragraph 3-5.

(b). Set the acquisition data console manual input in accordance with predicted data.

(c). Connect the manual input to the acquisition bus and notify the appropriate operators to slave all antennas to the bus.

(2). INITIAL ACQUISITION — ACTIVE ACQUISITION AID

(a). In the Mercury capsule there are two telemetry transmitters which operate at different frequencies in the 225- to 260-megacycle band. The transmitters operate at the same power, and normally either frequency may be used in tracking the capsule. Therefore, for initial acquisition and subsequent tracking, the active acquisition aid may be set at either frequency unless difficulty in acquisition and tracking is encountered. If difficulty is encountered, try the other frequency to see if better results are obtained.

(b). Watch the signal strength indicators and panalyzer and listen for telemetry audio. These will be the first indications that the capsule is in range.

(c). As soon as there are indications that a signal is being received, switch the active acquisition aid into automatic tracking and closely monitor its action as shown on the control console synchro displays.

(d). At low elevation angles the active acquisition aid may track a signal reflected from the ground. Therefore, closely monitor the control console synchro displays, particularly the elevation display. If the indicated elevation angle goes below the known horizon, switch to the manual elevation mode and position the antenna for minimum elevation error signal indication at an elevation above the horizon. Manually track the capsule in elevation until it is a few degrees higher and then switch back to fully automatic tracking. (Both channels in automatic.)

(e). By intercom, keep the acquisition data console operator informed of the status of tracking with the active acquisition aid. This status information is especially important during the critical, initial acquisition phase of the operation. As soon as fully automatic tracking is achieved and the quality of the track is verified by observation of the synchro displays, notify the acquisition data console operator of this fact in order to confirm the "AUTO" d-c mode indication (which was given when the active acquisition aid was switched into automatic).

(3). INITIAL ACQUISITION - VERLORT RADAR

The Verlort radar should remain slaved to the acquisition bus until a capsule signal is received by the active acquisition aid (unless of course the radar should locate the capsule before the active acquisition aid does). When a capsule signal is received by the active acquisition aid at a low elevation angle, the elevation channel of the Verlort should be switched from the slaved mode, and elevation searching begun. The azimuth channel of the radar should remain slaved to the active acquisition aid (through the acquisition bus) and elevation searching should be continued until the radar acquires the capsule or until the elevation of the capsule is sufficient to insure accurate tracking by the active acquisition aid (at least 10 and prefereably 15 degrees above the horizon). If this elevation is reached before the radar acquires the capsule, the elevation channel of the radar should be switched from the searching mode and again be slaved to the active acquisition aid until the capsule is acquired. If the FPS-16 radar acquires the capsule before the Verlort does, data from the FPS-16 will be switched onto the acquisition bus. Both channels of the Verlort should then be slaved through the acquisition bus to the FPS-16.

(4). INITIAL ACQUISITION - FPS-16 RADAR

Procedures for initial acquisition with the FPS-16 are the same as those for the Verlort, described in the preceding paragraph, except of course that if the Verlort acquires the capsule before the FPS-16 does, both channels of the FPS-16 should then be slaved through the acquisition bus to the Verlort radar.

(5). INITIAL ACQUISITION - ACQUISITION DATA CONSOLE

(a). As soon as notification is received from the active acquisition aid (by d-c mode indication or verbal communication) that it is tracking the capsule either automatically, manually by means of the error signal indicators, or manually with signal strength indication, switch the active acquisition aid data onto the acquisition bus. Data from the active acquisition aid when it is tracking in any of these modes is generally more accurate than the manual input settings on the acquisition data console.

(b). After one of the radars has acquired the capsule and is tracking it automatically, switch data from that radar onto the acquisition bus. Data from either radar is preferred to that from the active acquisition aid. When both radars are tracking the capsule automatically, switch data from the FPS-16 onto the bus as FPS-16 data is generally more accurate than the Verlort radar data.

(6). TRACKING

(a). Even after either of the radars acquires the capsule and is in the fully automatic tracking mode, continue to track the capsule with the active acquisition aid so that data will be available to the radar for re-acquisition if it loses the track before the capsule is out of range.

(b). Should the active acquisition aid lose the track, (radar still tracking automatically) switch the active acquisition aid to the acquisition bus (thus picking up the radar data) until the active acquisition aid re-acquires the capsule. Should both the radars and the active acquisition aid lose the capsule, proceed as follows:

1. Switch acquisition data console manual input data onto bus.
2. Set the manual input to the best position (estimated or in accordance with predicted data if available) for re-acquisition.
3. As soon as the active acquisition aid or one of the radars re-acquires the capsule, switch data from it onto the acquisition bus.

3-5. SYSTEM OPERATIONAL CHECKS

This paragraph describes the checks to be performed to ascertain that the acquisition data console and the overall acquisition system are in satisfactory operating condition. Detailed procedures for equipment other than the acquisition data console are given in the applicable individual equipment manuals. All of the checks for each individual piece of equipment and for the overall system are to be performed after initial turn-on of the equipment and again shortly before each Mercury operation. Only the operations to be performed are described in this paragraph. For detailed instructions on how to carry out the operations, see paragraph 3-4.

A. D-C INDICATIONS

(1). Check the console 28 VDC power supply and source switches in accordance with the instructions in paragraphs 3-2.B. and D.

(2). Direct the operators of the active acquisition aid, the receiving and transmitting antennas, the Verlort radar, and the FPS-16 radar to switch their equipment successively to all modes of operation; "AUTO," "SLAVED" and "MANUAL" for the active acquisition aid; "VALID TRACK," "SLAVED" and "MANUAL" for the radars; and "SLAVED" and "MANUAL" for the receiving and transmitting antennas. The equipment controls which give these indications are listed in table 3-III. As the operating modes are switched, check the appropriate console d-c mode indicators (figures 3-1 and 3-2) to see that they light when they should. While each indicator is lit, remove the display screen and see that both color filters are in place and that both lamps are lit.

(3). As the active acquisition aid is switched through its operating modes, direct the operators of the two radars to check the indications in the radars from the active acquisition aid. These are "AUTO" and "MANUAL." With no equipment slaved to the acquisition bus, depress successively the active acquisition aid and manual "SOURCE" switches on the console. Direct the radar operators to check the acquisition bus data indicators in the radars ("AAA" and "MANUAL"). As each radar is switched through its operating modes, direct the operator of each radar to check the "VALID TRACK" indication from the other.

(4). Direct the operators of the active acquisition aid and the receiving and transmitting antennas to set their antennas to approximately 260 degrees azimuth and then slowly rotate them in the clockwise (increasing azimuth) direction. As each antenna passes 270 degrees, the associated upper (clockwise indicating) cable wrap indicator on the acquisition data console should light. Direct the operators to set the antennas at approximately 280 degrees and then slowly rotate them in the counter-clockwise (decreasing azimuth) direction. As each antenna passes 270 degrees, the associated lower cable wrap indicator should light.

B. SYNCHROS AND SYNCHRO LINE AMPLIFIERS

(1). Set the acquisition data console manual inputs to zero degrees azimuth and elevation and switch this data onto the acquisition bus.

(2). Direct the operators of the active acquisition aid, the radars and the receiving and transmitting antennas to slave their equipment to the acquisition bus.

(3). Check the displays of antenna position on the acquisition data console and have the other equipment operators check their local displays. The active acquisition aid and radar antenna position displays should agree with the manual input displays within ±1.5 degrees. The receiving and transmitting antenna displays should agree with the manual input displays within ±3.0 degrees.

(4). With the acquisition data console handwheel, change the azimuth manual input from zero to 360 degrees in 30-degree steps and change the elevation manual input from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the antenna position displays for agreement with the manual input displays as in the preceding paragraph.

(5). With at least one antenna slaved to the bus (only one is necessary for the balance of these checks), switch data in turn from each of the remaining three sources onto the acquisition bus. The remaining three sources are the active acquisition aid, the Verlort radar, and the FPS-16 radar. As each source is connected to the bus, have the operator at the source manually vary the source through 360 degrees in azimuth and 90 degrees in elevation. At each 30-degree step in azimuth and elevation check the console displays from the source and from the slaved antenna. They should agree with the source data displays at the source within ±1.5 degrees or ±3.0 degrees, depending upon the particular antennas being used. When the two antennas being used are the active acquisition aid and one of the radars or are both of the radars, the accuracy requirement is ±1.5 degrees. For any other combination of source and slaved antenna, the requirement is ±3.0 degrees.

C. SIGNAL STRENGTH METERS

Check the calibration of the meters on the active acquisition aid control console signal strength meter panel in accordance with the instructions in paragraph 5-4.H.

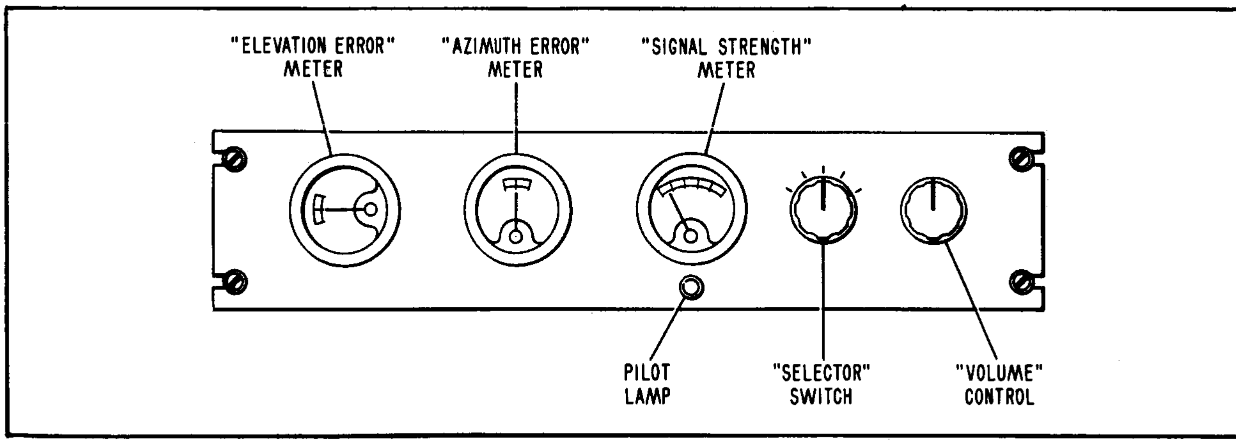


Figure 3-7. Active Acquisition Aid Control Console Meter and Switch Panel

3-6. EMERGENCY OPERATING PROCEDURE

Emergency operation of the acquisition system will be required under two general conditions. The first of these conditions is the unavailability of data from a source when it normally should be available. This unavailability could be due either to a malfunction of the source equipment or to simple failure to acquire the capsule. The second condition requiring emergency operation is a malfunction of a component, such as a relay or a synchro line amplifier, which does not directly affect a data source but which hinders or prevents communication or transmission of data. Procedures for operation under these two general conditions are discussed in the following paragraphs.

A. OPERATION WITH DATA SOURCE FAILURE

The procedure for operating when data from the normal source is not available is simply to use the next best data which is available. The order of preference of data sources is as follows:

(1). FPS-16 radar in fully automatic tracking.

(2). Verlort radar in fully automatic tracking.

(3). Active acquisition aid in fully automatic tracking.

(4). Active acquisition aid in manual tracking by error signal indication in one channel, automatic tracking in the other.

(5). FPS-15 radar in semi-automatic (one channel automatic, the other manual).

(6). Verlort radar acquisition in semi-automatic (one channel automatic, the other manual).

(7). Active acquisition aid in manual tracking by error signal indication in both channels.

(8). Active acquisition aid in manual tracking by means of signal strength indications. (Refer to paragraph 4-2.C.(2).(g).)

(9). Manual input at the acquisition data console.

(10). Independent manual positioning of antennas in accordance with tracking data read over the intercom system. This manner of operation would apply to the receiving and transmitting antennas if their connection to the acquisition bus was broken, but the radars or the active acquisition aid was operative and tracking the capsule.

(11). Independent manual positioning of antennas in accordance with predicted data.

B. OPERATION WITH COMPONENT MALFUNCTION

In many instances if a component fails and cannot be repaired or replaced in the time available, temporary circuit connections can be made which will allow at least limited operation of the system. It is of course impractical to attempt to give specific instructions covering all possible failures; maintenance personnel must have sufficient knowledge of the system to devise temporary fixes on the spot. However, to illustrate the types of fixes that might be used, some examples are given in the following paragraphs.

(1). ACQUISITION DATA CONSOLE 28 VDC POWER SUPPLY

(a). Each of the two 28 VDC power supplies in the acquisition data console is capable of easily supplying all of the current needed in the console and 28-volt devices connected to it. Therefore, failure of one supply reduces the reliability of the console, but does not make it inoperative.

(b). Should both of the console 28-volt supplies fail, 28 VDC can be supplied to the console from other, nearby equipment (preferably the communication technician's console): Turn off the dual power supply OFF-ON switch (figure 3-3) and check the console 28 VDC bus to see that it is not shorted to ground. Jumper any convenient terminal on the console 28 VDC bus (see figure 7-1) to a source in other equipment which can supply about one ampere in addition to its normal load. (The communication technician's console 28 VDC supply easily meets this requirement.) Also connect a jumper between acquisition data console ground and the negative side of the external 28-volt supply. The acquisition data console can now be operated normally except for turning 28 VDC off and on.

(2). RELAYS

Defective relays can be "fixed" by jumpering the normally open contacts. For instance, should the acquisition data console relay (K6003) which connects data from the active acquisition aid to the acquisition bus fail, data from the active acquisition aid can be connected to the bus by placing jumpers between terminal boards TB6006 and TB6009. (See figure 7-1.)

(3). SYNCHRO LINE AMPLIFIERS

A malfunctioning synchro line amplifier in a critical location in the system, such as in the acquisition bus, can be replaced by another amplifier from a less critical place, such as a display data circuit. Also, synchro line amplifiers can be temporarily "fixed" by removing them from the circuit and jumpering their inputs to the corresponding outputs. However, this action would introduce 180-degree phase reversal, and the line amplifier synchro circuit would have to be adjusted accordingly.

(4). SYNCHROS

Like synchro line amplifiers, a defective synchro in a critical place can be replaced by another synchro from a less critical place. For example, if one of the azimuth or elevation manual input synchro receivers on the acquisition data console fails, it can be replaced by the receiving or transmitting antenna azimuth or elevation display synchro receiver on the console.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

With the exception of the acquisition data console, which is treated in detail, this section presents the theory of operation of the acquisition system on a block diagram level. Adjoining systems, those which receive information from or supply information to the acquisition system, are treated only to the extent of their interconnections with the acquisition system. For further information on these systems, see the applicable system manuals. For detailed information on the components of the acquisition system which are described only on a block diagram level, see the applicable equipment manuals. These manuals are listed in table 1-II.

A. FUNCTION OF THE SYSTEM

As was described in Section I, the function of the acquisition system is to take the best data available on the capsule's azimuth and elevation at any given time and make it available on the acquisition bus for use by the active acquisition aid, the receiving antenna, the transmitting antenna, and the radars. (The acquisition bus is the "common" line which distributes data to the using equipment.) The active acquisition aid and the radars use the data from the acquisition bus as an aid in acquiring the capsule for automatic tracking. As soon as they begin automatic tracking, the active acquisition aid and the radars stop using data from the acquisition bus; however, under most conditions during a pass, acquisition data is still available to the active acquisition aid and the radars for use in re-acquiring the capsule if automatic tracking is lost before the capsule is out of tracking range. The receiving and transmitting antennas and their associated equipment cannot track a target automatically. Therefore, these antennas are normally slaved to data from the acquisition system at all times during a pass.

B. DATA INPUTS

Data inputs to the acquisition system at Kauai Island are available from four sources: manual input, active acquisition aid, Verlort radar, and FPS-16 radar. At the acquisition data console data from the best (most accurate) of these four sources is switched onto the acquisition bus and thereby made available to all of the steerable antennas on the site (except the one, if any, which is the source of the data on the bus).

(1). Manual input to the acquisition system is made with synchro transmitters on the acquisition data console. These synchros are positioned by means of handwheels in accordance with predicted capsule azimuth and elevation data based on computations of the capsule's orbit.

(2). Acquisition data from the active acquisition aid and the radars is taken from the synchro transmitters which are mechanically coupled to their antennas. Data from the active acquisition aid is transmitted to the acquisition data console. Data from the radars is connected to the acquisition bus through radar control relays. These control relays are energized by the operator at the acquisition data console. (See the synchro stator circuit connection diagrams in Section VII.)

C. NORMAL OPERATION

The following is a description of the normal sequence of availability, distribution and use of acquisition information during a typical pass of the capsule. This description is given as an aid in understanding the overall operation of the acquisition system. It should be noted that several variations from the normal sequence are possible. These variations are not discussed in the following description, but should be apparent once the capabilities of the system are understood.

(1). Prior to the pass, predicted target position coordinates — azimuth, elevation, range, and time — are sent to the site in plain text from Goddard Space Flight Center. Coordinates for four or five different times along the orbit are sent: time of arrival at 700 nautical miles range, 30 seconds later, 60 seconds later, 90 seconds later, and time for position just past zenith when a zenith pass of the capsule is expected. The first set of coordinates is read over the intercom to the acquisition data console operator who sets the manual input synchros accordingly and puts this data on the acquisition bus. The active acquisition aid, receiving, transmitting, and both radar antennas are slaved to the manual input. If acquisition (automatic tracking) of the capsule is not accomplished at the time specified by the first set of predicted coordinates, the next three of the remaining sets of coordinates are read and set into the system at the times given. The coordinates just past zenith are used as an aid in re-acquiring the capsule if automatic tracking is lost as it passes overhead.

(2). The active acquisition aid acquires the capsule, and data from the active acquisition aid is put onto the acquisition bus by the acquisition data console operator. Thus, the active acquisition aid is no longer slaved to the bus (as it is the source of the data on the bus). However, the other antennas at the site remain slaved to the bus.

(3). The Verlort radar acquires the capsule. Since it is more accurate, data from the Verlort is preferred to that from the active acquisition aid, Verlort data is switched onto the acquisition bus. The receiving and transmitting antennas and the FPS-16 radar remain slaved to the bus. The active acquisition aid, however, continues independent automatic tracking.

(4). The FPS-16 radar acquires the capsule. Since it is the most accurate of all the tracking data obtainable, data from the FPS-16 is switched onto the acquisition bus. The receiving and transmitting antennas remain slaved to the bus, and the Verlort radar and the active acquisition aid continue in independent automatic tracking. These conditions —both radars and the active acquisition aid tracking automatically, FPS-16 data on the acquisition bus, and the receiving and transmitting antennas slaved to the bus —are the optimum for the remainder of the capsule pass. They are continued until the capsule goes beyond the range of the FPS-16.

(5). When the capsule goes out of range of the FPS-16, but the Verlort is still tracking, FPS-16 data is switched off the bus and Verlort data is switched onto it. The receiving and transmitting antennas remain slaved, and the active acquisition aid continues automatic tracking.

(6). If the Verlort loses automatic tracking before the active acquisition aid, data from the active acquisition aid is switched onto the bus. Otherwise, the Verlort continues to track and its data is kept on the acquisition bus until the capsule pass is complete. In either event, the receiving and transmitting antennas remain slaved to the acquisition bus until all automatic tracking ceases.

4-2. DETAILED DISCUSSION

A. DISCUSSION OF OVERALL SYSTEM

This paragraph discusses the complete acquisition system on a block diagram level (see figures 4-1 and 4-2 and the synchro circuit connection schematics in Section VII.) Paragraph 4-2.B. and subsequent paragraphs discuss individual components and subsystems of the acquisition system.

(1). On the acquisition data console at the data source selector, which consists of several relays and switches, azimuth and elevation data from one of the four possible sources is put onto the acquisition bus. (The acquisition bus is indicated by the heavy lines on figure 4-1.) This data goes to synchro line amplifiers numbers 4 through 8.

(2). From the synchro line amplifier number 4, data goes to the active acquisition aid and to the receiving antenna.

(a). The active acquisition aid does not use the data on the acquisition bus when it is tracking the capsule automatically. However, when it is not tracking automatically, the active acquisition aid can usually be slaved to the data on the bus.

(b). The receiving antenna is normally slaved to the data on the acquisition bus at all times during a capsule pass.

(3). From synchro line amplifier number 5, data goes to the transmitting antenna. The transmitting antenna is normally slaved to the data on the acquisition bus at all times during a capsule pass.

(4). From synchro line amplifier number 6 the data goes to the Verlort radar. When the Verlort is tracking the capsule automatically, it does not use the data from the acquisition bus. When it is not engaged in automatic tracking, however, the Verlort can usually be slaved to the bus. (It cannot be slaved to the bus when it is the source of the data on the bus.)

(5). From synchro line amplifier number 7 the data on the acquisition bus goes to the FPS-16 radar. As in the case of the Verlort radar, the FPS-16 radar does not use data from the acquisition bus when it is tracking automatically. When it is not tracking automatically, it can usually be slaved to the bus.

(6). From synchro line amplifier number 8, the data on the acquisition bus goes to the PMR Van. Like the receiving and transmitting antennas, the antenna associated with the PMR Van is normally slaved to the data on the acquisition bus at all times during a capsule pass.

(7). Position and display data are fed to the acquisition data console from the manual input, the active acquisition aid, the Verlort radar, the FPS-16 radar, and the receiving and transmitting antennas. The manual input comprises two synchro transmitters which are positioned by handwheels: one transmitter and handwheel for azimuth data and one for elevation data. The output of the transmitters goes to the data source selector and to synchro displays.

(8). The active acquisition aid puts out azimuth and elevation position data and azimuth and elevation display data. The outputs come from four synchro transmitters, two for position data and two for display data, whose rotors are mechanically coupled to the antenna. Both position and display data are fed to the acquisition data console. (See figure 7-7.) The position data is routed to the data source selector where it can be put onto the acquisition bus, and the display data goes to the synchro receiver displays for monitoring.

(9). As with the active acquisition aid, azimuth and elevation data from the Verlort radar is taken from four separate synchro transmitters, two for position data and two for display data. Display data goes through synchro line amplifier number 1 to the acquisition data console where it is displayed by synchro receivers. Position data from the Verlort does not go through the acquisition data console, but is connected to the acquisition bus at the radar by the radar control relay when the Verlort radar is chosen as the source of data for the bus. (See figure 7-9.) The radar control relay is energized by the acquisition data console operator.

(10). As in the case of the Verlort radar, position data from the FPS-16 radar is routed to the acquisition bus through the radar control relay at the radar. The control relay is energized by the operator at the acquisition data console. Display data from the FPS-16 radar is fed to the synchro displays on the acquisition data console through synchro line amplifier number 2. (See figure 7-11.)

(11). Display data from the receiving antenna is fed directly to acquisition data console synchro displays, where it is used for monitoring. (See figure 7-12.)

(12). Display data from the transmitting antenna is fed to synchro displays on the acquisition data console through synchro line amplifier number 3. (See figure 7-13.) These displays are used for monitoring the operation of the transmitting antenna.

(13). D-c indications of equipment operating mode and of other information are used in the acquisition system. These indications permit the system operators to monitor the status of the various pieces of equipment, and especially they provide the acquisition data console operator with information he needs to control and direct the operation of the system. Five d-c indications come from the active acquisition aid to the acquisition data console. (See figure 4-2.) Two of these are cable wrap indications and three are operating mode indications. The cable wrap indications show which half of its total azimuth travel (540 degrees) the active acquisition aid antenna is in, and when used with the azimuth synchro display from the active acquisition aid permit the acquisition data console operator to tell where the antenna is relative to its azimuth limits. The operating mode indications show whether the active acquisition aid is in its automatic, slaved, or manual mode of operation. The automatic and manual tracking mode indications also go from the active acquisition aid to the Verlort and FPS-16 radars.

(14). Mode indications from both of the radars to the acquisition data console are valid (automatic) tracking, slaved, and manual. In addition to going to the acquisition data console, the valid track indication from each radar goes to the other. Also, two indications go from the acquisition data console to each radar. These show whether data from the active acquisition aid or from the manual input is on the acquisition bus.

(15). Both the receiving and transmitting antennas have two cable wrap and two operating mode indications going to the acquisition data console. The cable wrap indications have the same purpose as those from the active acquisition aid, and the operating mode indications show whether the antennas are slaved to data on the acquisition bus or are being manually operated.

(16). Synchro stator voltages, as shown on figure 4-1, are transmitted from place to place without voltage transformation. The synchro reference voltages, however, undergo voltage step-up and step-down transformation in order to avoid transmitting relatively large currents over considerable distances. These voltage transformations are shown in simplified form on figure 4-3. Synchro reference voltage of 115 VAC from the power distribution panel is stepped up to 480 VAC for distribution to the equipment in and connected to the acquisition system. A transformer in the acquisition data console steps the 480 down to 115 VAC for use by the synchros in the console and the active acquisition aid. For each of the other units in or connected to the acquisition system, a separate transformer steps the 480 volts down to 115 VAC as shown on the illustration. (For an explanation of the

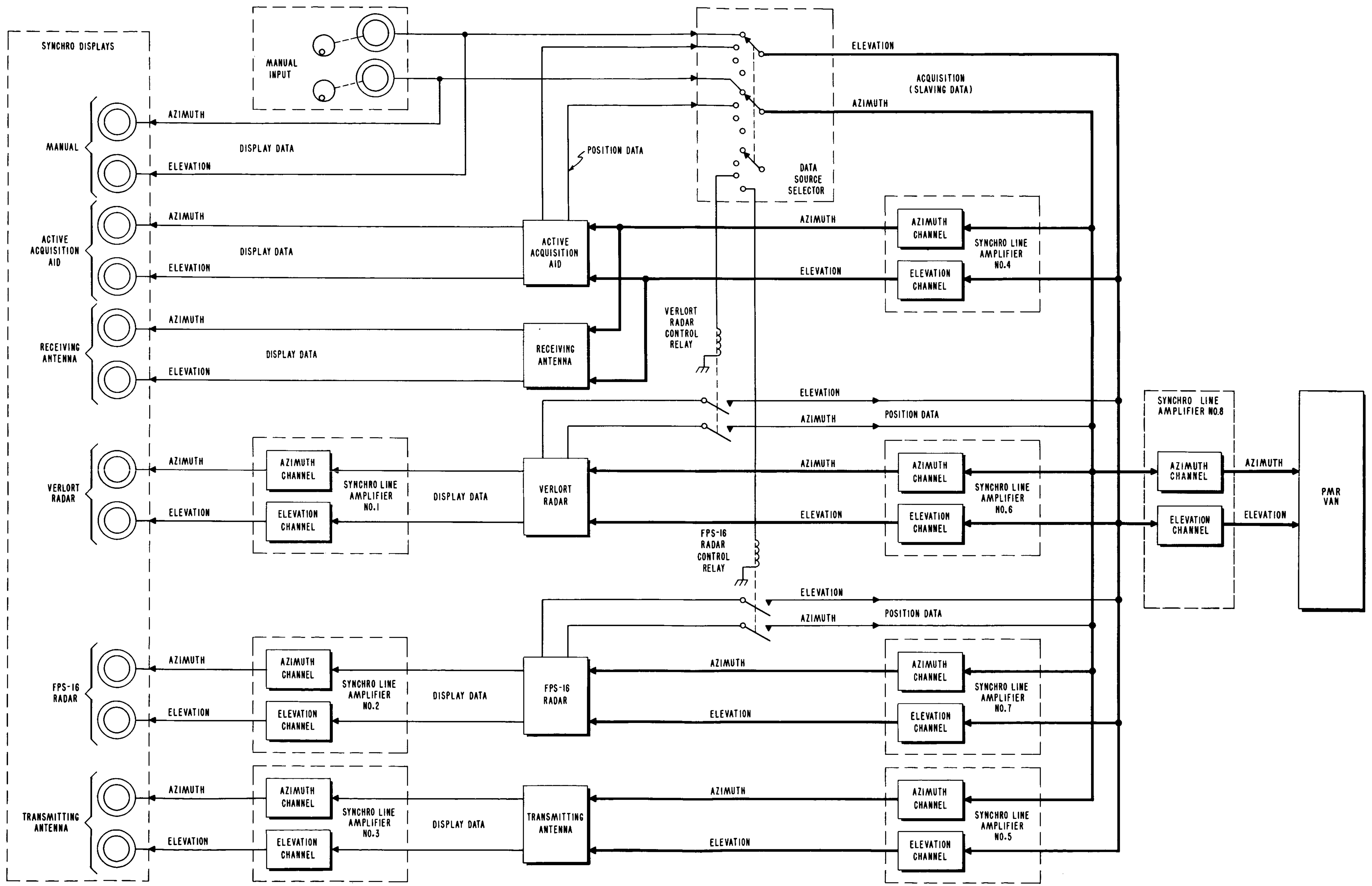


Figure 4-1. Acquisition System, Block Diagram

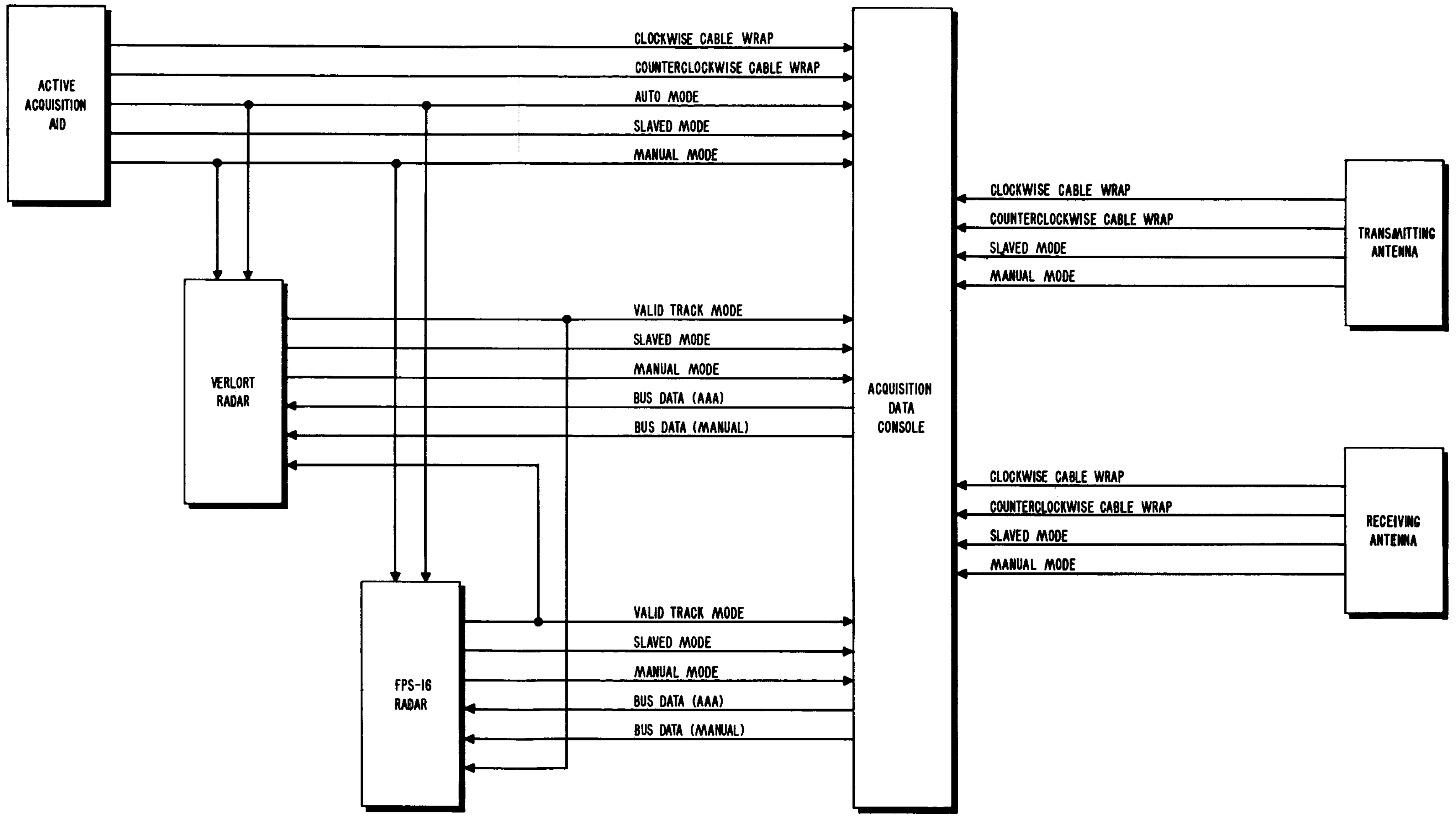


Figure 4-2. Acquisition System D-c Indications, Block Diagram

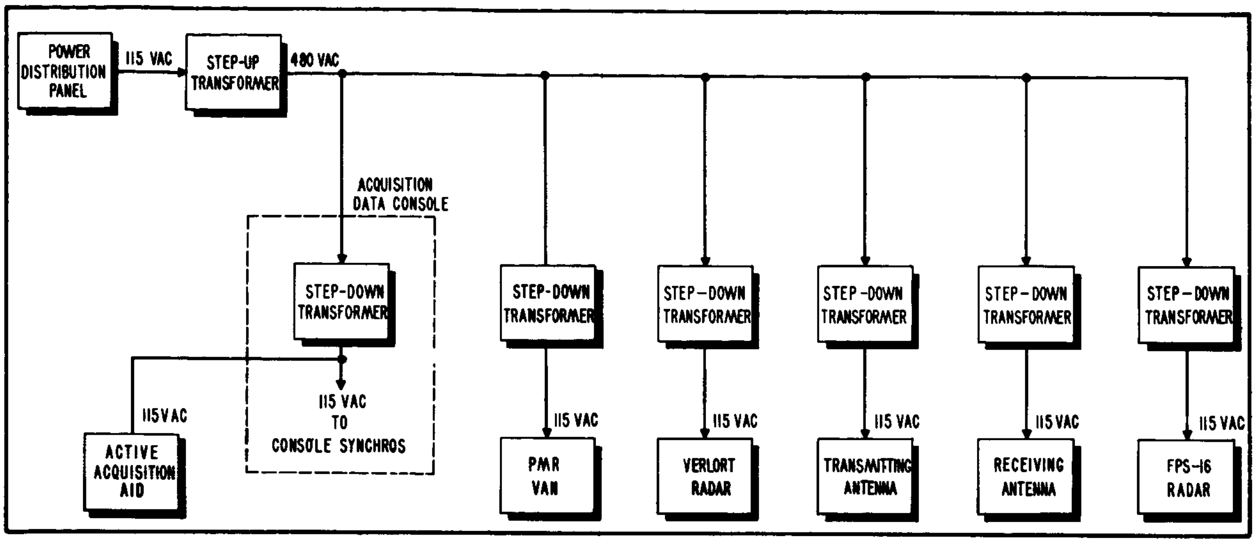


Figure 4-3. Synchro Reference Voltage Transformation and Distribution

nature and purpose of synchro reference and stator voltages, refer to paragraph 4-2.E(1).(b).

B. ACQUISITION DATA CONSOLE

(1) DUAL POWER SUPPLY

Switches, indicators, and relays on the acquisition data console are energized by 28 VDC from the console 28 VDC supply, which consists of a relay chassis, two switches on the acquisition data panel, and the dual power supply. The dual power supply consists of four chassis (two power supply units and two filter units) and a front panel. (See figure 7-3.) Primary power, 115 VAC, is applied through jacks J6201 and J6202 to off-on switch S6201. When switch S6201 is closed, primary power is applied through fuses F6201 through F6204 to the primaries of power transformers T6201 and T6202. The fuses are in indicating-type holders; when a fuse blows, a neon bulb in parallel with the fuse is lit. A neon, power-on indicating lamp, DS6201, is across the line going to power supply unit PS6201. Power supply unit PS6201 and filter unit FL6201 make up power supply number 1; it is a conventional d-c power supply with silicon rectifiers in a bridge configuration and with an LC filter. Note that there is a fuse, F6205, on the d-c side of the power supply. This fuse is not in an indicating-type holder. Power supply unit PS6202 and filter unit FL6202 make up power supply number 2, a second d-c power supply which is identical to the first. The secondaries of power transformers T6201 and T6202 have multiple taps to allow adjustment of the output voltage of the power supplies. The voltage difference between taps 1 and 2 is 1.5 VAC and is 3 VAC between taps 3 and 4, 4 and 5, and 5 and 6. Thus, by connecting the a-c leads to the rectifier to different taps on the transformer, the a-c input to the rectifier can be varied over a range of 10.5 volts, (rms), and the d-c output of the power supply over a range of approximately 14.5 volts.

(2). POWER SUPPLY CONTROL CIRCUITS

The control circuits for the console power supply are shown in simplified form in figure 4-4. Each of the blocks in figure 4-4 labeled "28 VDC POWER SUPPLY" represents half of the dual power supply discussed in the previous paragraph and shown on figure 7-3. Switches S6006 and S6007 and the indicator lamps are on acquisition data panel number 1; the rest of the components of the control circuits are on the relay chassis which is mounted on the left rack of the console.

(a). When switch S6201 on the dual power supply is closed (see figure 7-3), power is applied to power supply number 1 in the dual power supply through manually operated pushbutton switch S6006. The power supply puts 28 VDC on the bus, and relay K6001 is energized. Power is applied through K6001 contacts 5 and 6 to the coil of switch S6006, holding switch S6006 closed and keeping the power supply on. With relay K6001 energized, power is applied through K6001 contacts 1 and 2 to the green indicator lamps, which indicate that the power supply is on and operating properly. If power supply number 2 of the dual power supply has not yet been turned on, 28 VDC from power supply number 1 through relay K6002 contacts 2 and 4 lights the red indicator lamps associated with power supply number 2, indicating that it is not on. Rectifier CR6002 prevents current from power supply number 1 from circulating through power supply number 2 and from energizing relay K6002 when power supply number 2 is not on.

Note

The indicator lamps associated with power supply number 1 are in the same unit as

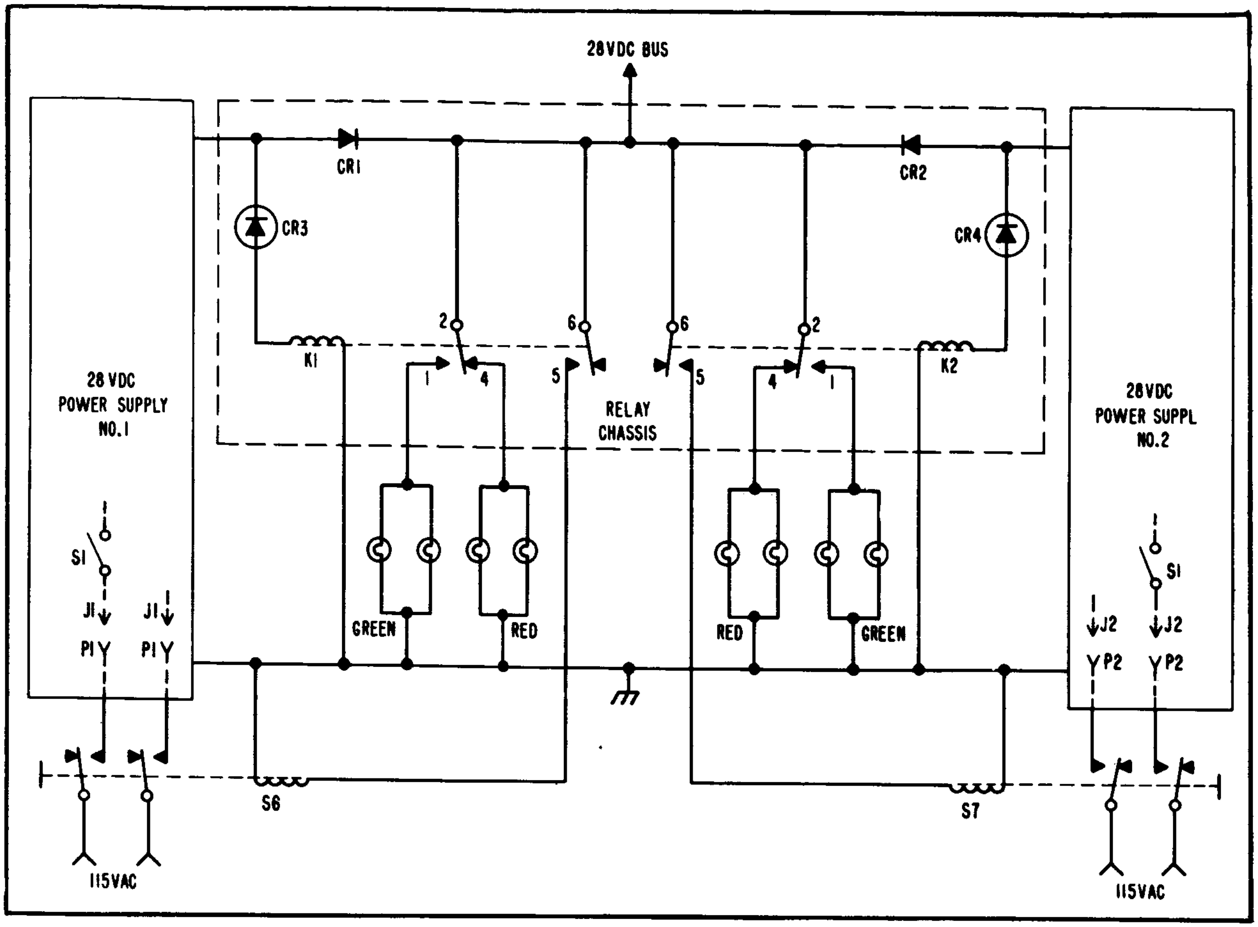


Figure 4-4. Power Supply Control Circuits, Simplified Schematic Diagram

switch S6006; the lamps associated with power supply number 2 are in the same unit as switch S6007.

(b). Zener diode CR6003 in series with the coil of relay K6001 provides a sharp pull-in and drop-out of relay K6001 as the voltage output of power supply number 1 increases or decreases. This action prevents the output of power supply number 1 from being applied to the console 28 VDC bus until it reaches operating value, and in the case of a malfunction resulting in low voltage, disconnects the power supply from the bus. When power supply number 1 is turned on, its voltage output begins to rise. Until the output reaches 18 volts, the resistance of CR6003 is very high, and virtually no current flows through CR6003 and the coil of K6001. As the power supply output increases above 18 volts, the resistance of CR6003 decreases, and rapidly increasing current flows through CR6003 and K6001. (The distinguishing characteristic of zener diodes is that with applied voltages above the diode reference value, 18 volts in this case, and below the maximum rated value, the resistance of the diode varies inversely with the applied voltage. Current through the diode varies greatly, but the voltage drop across it remains practically constant. The action of the diode is thus like that of a VR tube.) When the supply voltage reaches approximately 22.5 volts, sufficient current flows (4.5 milliamperes) to energize relay K6001. Since the resistance of the relay coil is 1000 ohms, the values of voltage and current in the circuit at this point are as follows:

Total applied voltage	22.5 VDC
Voltage drop across CR6003	18.0 VDC
Voltage drop across K6001 coil . . .	4.5 VDC
Current $\left(\frac{4.5}{1000}\right)$	4.5 MA

As the power supply output continues to increase, the voltage drop across CR6003 remains at about 18 volts, the current through the circuit increases to about 10 milliamperes, and the voltage drop across the K6001 coil increases to about 10 volts.

(c). If a malfunction develops such that the output voltage of power supply number 1 begins to drop, relay K6001 will drop out sharply at an output voltage of about 22.5 volts. This action is due to the sharp increase in the resistance of zener diode CR6003 as the voltage across it drops to 18 volts. (As explained in the previous paragraph, with an output from the power supply of 22.5 volts, 4.5 volts appear across the coil of relay K6001 and 18 volts across diode CR6003.) Blocking diode CR6001 prevents current from power supply number 2 from flowing through diode CR6003 and relay K6001. When relay K6001 is de-energized, the holding coil circuit of switch S6006 is opened (by the opening of K6001 contacts 5 and 6) and primary power is disconnected from power supply number 1.

Note

In the preceding and following discussions the values of voltage, current, and resistance given are for purposes of explanation. Actual circuit values vary slightly from those given. For instance, 4.5 milliamperes is the maximum current (per manufacturer's data) which is required for pull-in of relays of the type employed in the control circuit (K6001). The pull-in current for individual relays, however, varies downward from this value. Also, the dropout current of any individual relay is less than the pull-in current. Hence, relay K6001 may be expected to pull in at a total applied voltage somewhat less than 22.5 VDC and to drop out at a still lower voltage.

(d). The action of the control circuit of power supply number 2 is identical to that of the control circuit of power supply number 1.

(e). A summary of the action of the power supply control circuits is as follows:

1. Switch S6006 is manually closed, and primary power is applied to power supply number 1 (assuming that switch S6201 on the dual power supply has been closed).

2. Power supply number 1 puts 28 VDC on the bus, energizing relay K6001 and lighting the red indicator lamps in the control circuit of power supply number 2.

3. Relay K6001 closes, lighting the green indicator lamp associated with power supply number 1 and applying power to the holding coil of switch S6006.

4. Switch S6006 remains closed, and power supply number 1 is in operation.

5. Switch S6007 is closed, and primary power is applied to power supply number 2.

6. Power supply number 2 puts 28 VDC on the bus in parallel with the power from power supply number 1.

7. Relay K6002 is energized, turning off the red indicator lamps associated with power supply number 2 and lighting the green indicator lamps. Power is applied through K6002 contacts to the holding coil of switch S6007, holding S6007 in the on position. Both power supplies are now in operation.

8. Both power supplies are turned off by opening switch S6201 on the dual power supply.

9. If the voltage output of one of the power supplies drops to approximately 22.5 volts, the control relay (K6001 or K6002) associated with the malfunctioning power supply is de-energized and the primary power to that power supply is removed. Power from the other power supply lights the red indicator lamps of the malfunctioning supply. The ratings of the power supplies are such that one of them can supply all of the power required by the console in the event of the failure of the other.

(3). <u>SWITCHES AND INDICATORS</u>

(a). A number of switch assemblies and indicator assemblies are used on the acquisition data panels of the acquisition data console. An exploded view of the type of switch assembly used is shown in figure 4-5. The assembly consists of two main detachable sections: the switch and the operator-indicator unit with coil. The switch has up to four single-pole, double-throw sections. All of the switch sections are actuated simultaneously by a plunger in the operator-indicator unit. The operator-indicator unit has two main non-detachable sections: the coil and the indicator. When energized, the coil holds the plunger in its actuated position. The indicator has four lamp sockets, lamps, color filters, and a three-piece display screen. The lamps are white, so the colored lighting of the indicator is obtained by the use of filters which fit over the lamps. The display screen snaps into the end of the indicator plunger when the indicator is assembled, so that the plunger is moved and the switch actuated by depressing the display screen.

(b). The indicator assemblies used on the console are like the operator-indicator unit shown on figure 4-5, except that the indicator assemblies have no coil and no plunger.

(4). CIRCUIT DESCRIPTION (Figure 7-1)

This paragraph gives a detailed description of the circuits of the acquisition data console except for the power supply, which is described in a previous paragraph, and the synchro line amplifiers, which are covered in paragraph 4-2.D.

(a). D-C INDICATIONS

The operating modes of the active acquisition aid, the radars, and the receiving and transmitting antennas are indicated by lamps on the acquisition data console. Some of these lamps are supplied with 28 VDC from the console power supply, with ground supplied through switches in external equipment. Others are connected to ground in the console, and 28 VDC is supplied through switches in external equipment. For instance, when the active acquisition aid is tracking automatically, the active acquisition aid operator closes a switch which connects 28 VDC to terminal 1 of terminal board TB6008 in the console, thus lighting active acquisition "AUTO" indicators DS6001 and DS6002. Other operating mode indicators on the console are as follows:

1. Manual tracking by the active acquisition aid is indicated by the lighting of active acquisition aid "MANUAL" indicators DS6005 and DS6006, and the slaved mode is shown by "SLAVED" indicators DS6003 and DS6004. One side of the "MANUAL" indicators is connected to 28 VDC in the console, and ground is connected to the other side through the "MANUAL" switch in the active acquisition aid and terminal 3 of console terminal board TB6008. One side of the "SLAVED" indicators is

connected to console ground, and 28 VDC is applied to the other side through the "SLAVED" switch in the active acquisition aid and terminal 2 of TB6008 on the console. Active acquisition aid mode indicators in the radars also are connected to TB6008 terminals 1 and 3. Thus, "AUTO" and "MANUAL" mode indications from the active acquisition aid appear in the radars at the same time that they appear on the acquisition data console.

2. The active acquisition aid antenna can rotate 540 degrees in azimuth from its clockwise to its counterclockwise limit. Since it can rotate more than 360 degrees, there are azimuths at which the synchro display alone is ambiguous; i.e., the synchro display shows the azimuth of the antenna, but does not show whether it is on its first or second time around. Since the antenna cannot rotate continuously, it is necessary to know where it is relative to its limits of rotation so that the operator can position it for maximum freedom of rotation in either direction and can avoid driving it into its limit stops. The ambiguity of the synchro display is resolved by the use of "CABLE WRAP" indicator lamps DS6059 and DS6060 which are lit by the closing of a switch on the antenna pedestal. This switch is so located that it is actuated when the antenna passes the mid-point between its azimuth limits. The DS6059 circuit is closed by the switch and the DS6060 circuit is opened when the antenna is rotating clockwise (looking at it from above). The DS6060 circuit is closed and the DS6059 circuit opened when the antenna is rotating counterclockwise. At installation the antenna is so oriented that the counterclockwise limit is reached at zero degrees (relative to north) and the clockwise limit at 180 degrees. (See figure 4-6.) With this orientation, the cable wrap indicator switching occurs at 270 degrees. Figure 4-7 illustrates how the cable wrap indicator lamps and the antenna azimuth display synchro together show the acquisition data console operator where the antenna is relative to its

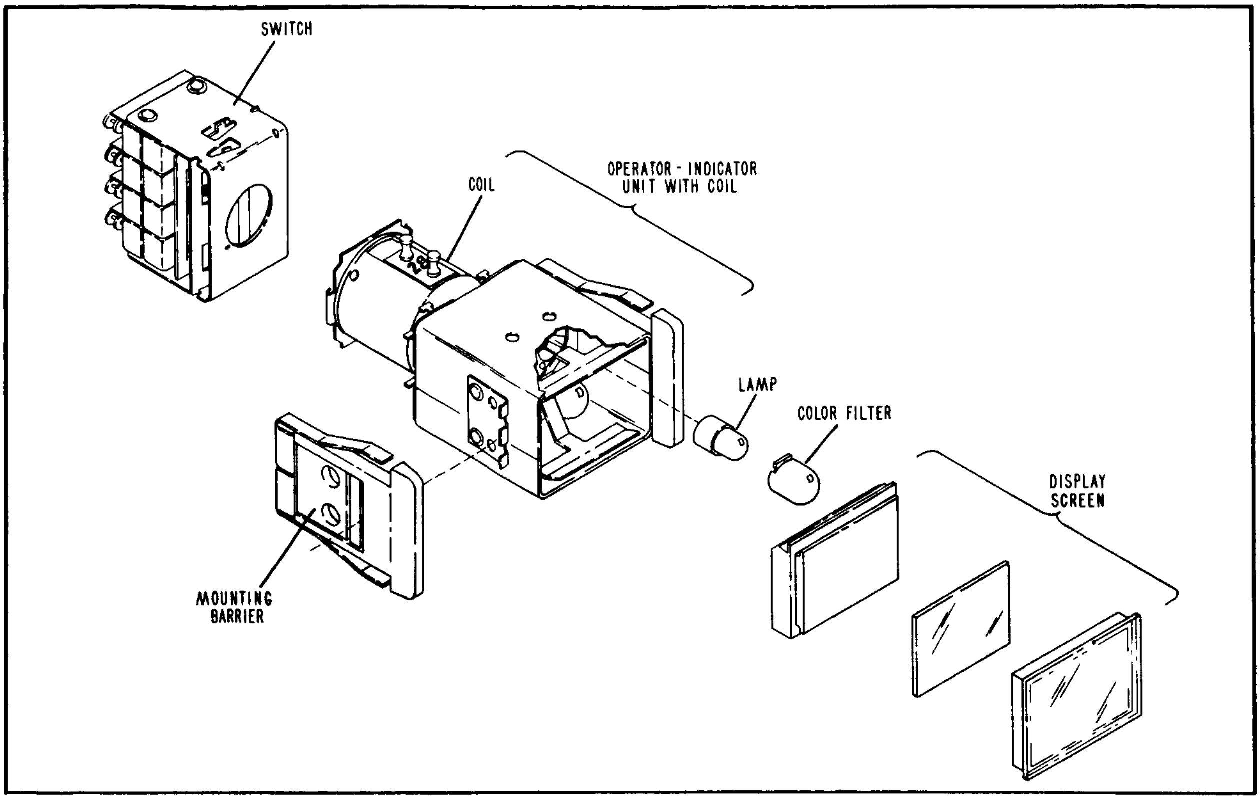


Figure 4-5. Switch Assembly, Exploded View

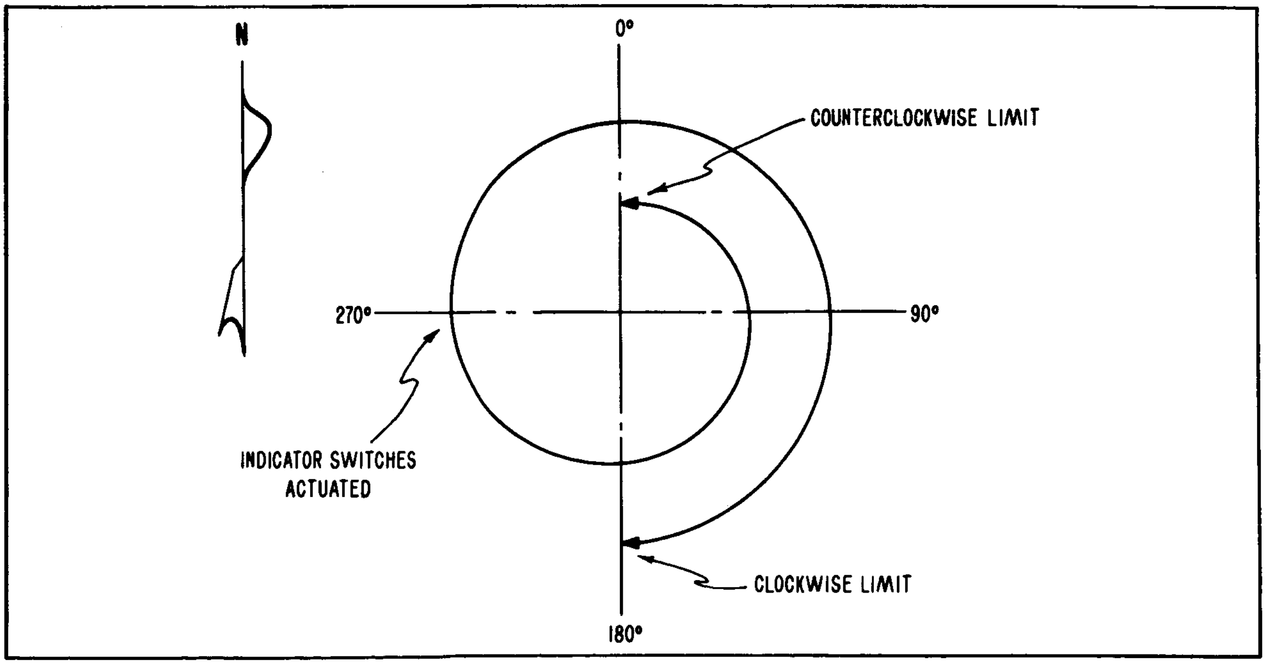


Figure 4-6. Diagram of Antenna Cable Wrap Limits

limits of rotation. When the upper cable wrap indicator is lit (figures 4-7(A) and 4-7(B)), the antenna has been turned past 270 degrees azimuth in a clockwise direction, and if it continues in a clockwise direction, the limit of rotation will be reached at 180 degrees azimuth. When the lower indicator is lit (figures 4-7(C) and 4-7(D)), the antenna has been turned past 270 degrees in a counterclockwise direction, and continuing in a counterclockwise direction the limit will be reached at zero degrees. Thus, as long as the synchro pointer is on the half of the dial (upper or lower) which is the nearer to the lighted indicator (figures 4-7(A) and 4-7(C)), there is no limit problem and the antenna can safely be turned in either direction. When the synchro pointer is on the half of the dial opposite the lighted indicator (figures 4-7(B) and 4-7(D)), the antenna is near one of its limits of rotation and care must be exercised not to drive it into the limit stop.

3. The circuits in the active acquisition aid which provide d-c indications to the acquisition data console are shown in partial form on figure 7-18. The mode of operation of the active acquisition aid is determined by the condition (energized or not energized) of a number of mode control relays. When none of these relays is energized, the active acquisition aid is in the manual mode. One group is energized for automatic operation, and another group is energized for slaved operation. The manual mode indicators in the acquisition data console are grounded through normally closed contacts (3 and 2) of relays K1152 and K1151 in the active acquisition aid servo cabinet field and relay power supply. Relay K1152 is energized for automatic operation, and relay K1151 is energized for slaved operation. Hence, for either operating mode of the active acquisition aid other than manual, ground is removed from the manual indicators on the acquisition data console, and the indicators are extinguished.

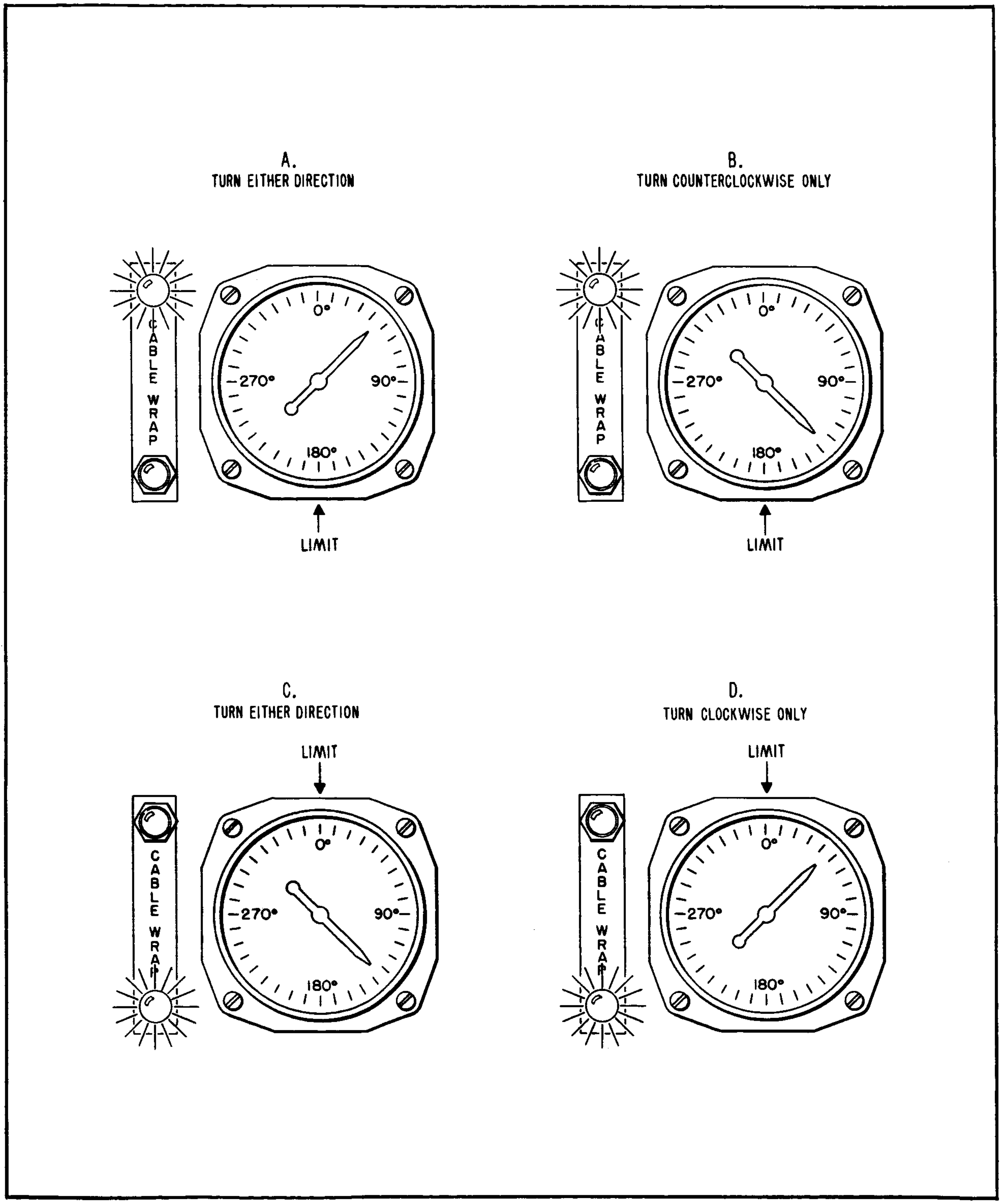


Figure 4-7. Synchro and Lamp Indications of Antenna Bearing Relative to Cable Wrap Limits

4. For automatic operation of the active acquisition aid, "AUTO" switch S67607 on the control console switch panel assembly is closed, thus connecting 28 VDC from the field and relay power supply to mode control relay K1152. In addition to connecting 28 VDC to K1152, the closing of S67607 connects 28 VDC to the "AUTO" mode indicators in the acquisition data console, thus lighting these indicators. (Switch S67607 is a momentary type. After initial application of 28 VDC through S67607, relay K1152 is kept in the energized position by a holding circuit, not shown on figure 7-18.)

5. For slaved operation of the active acquisition aid, "SLAVED" switch S67608 on the switch panel assembly is momentarily closed. Providing that the slaving interlocks on the acquisition data console are closed (the operation of these interlocks is described in paragraph 4-2. B. (4). (c).), this action connects 28 VDC to relay K1151 (and other mode control relays, as shown on figure 7-18), thus energizing it and completing its holding circuit. The 28 VDC on the coil of K1151 is applied in parallel to the "SLAVED" mode indicators on the acquisition data console, thus lighting them.

6. The active acquisition aid cable wrap indicators on the acquisition data console are operated in parallel with the indicators on the active acquisition aid control console. The complete circuit is shown on figure 7-18.

7. The operating mode of the receiving antenna is indicated by "SLAVED" indicators DS6029 and DS6030 and "MANUAL" indicators DS6031 and DS6032. Twenty-eight volts d-c is applied to these indicators by the receiving antenna mode ("LOCAL-REMOTE") switch (on the receiving antenna servo cabinet) through terminal board TB6021 terminals 1 and 2.

8. The two channels, azimuth and elevation, of the receiving antenna drive system are independent of one another to the extent that either channel can be operated in the slaved or manual

mode while the other channel is operated in the other mode. The "LOCAL-REMOTE" (mode) switches of the antenna are connected to the operating mode indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified form on figure 4-8. From the illustration it can be seen that when both the azimuth and elevation "LOCAL-REMOTE" switches are in the "REMOTE" (slaved) position, 28 VDC is applied to the "SLAVED" indicator on the acquisition data console. When either "LOCAL-REMOTE" switch is in the "LOCAL" (manual) position, 28 VDC is applied to the "MANUAL" indicator on the console.

9. The receiving antenna "CABLE WRAP" indicators on the acquisition data console perform the same function as the active acquisition aid cable wrap indicators, previously described.

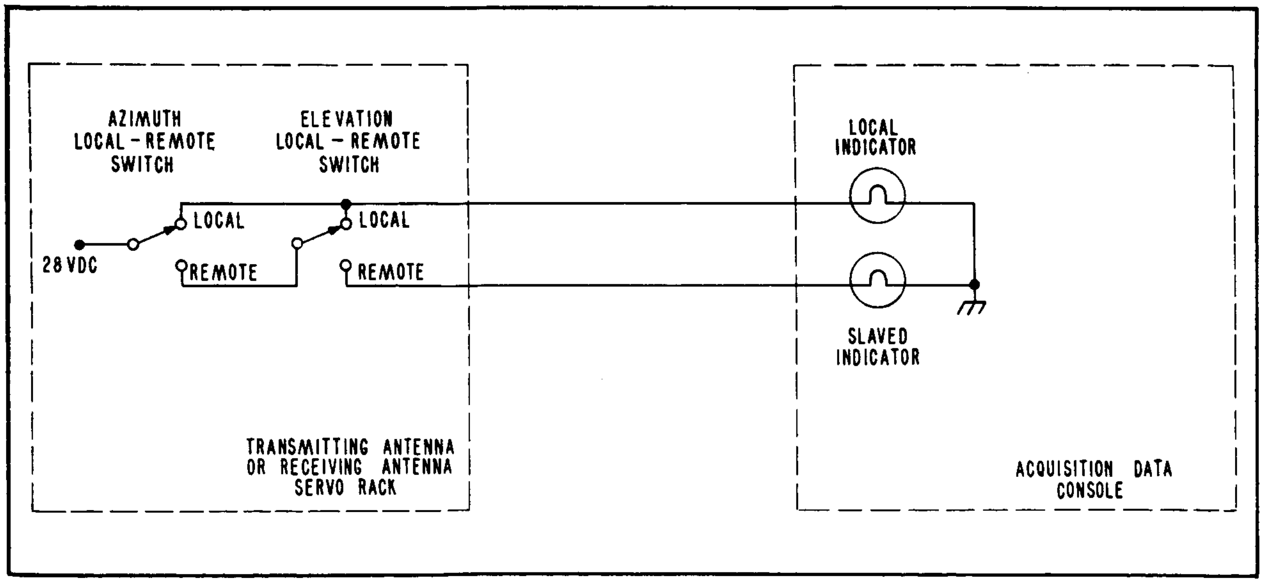


Figure 4-8. Receiving and Transmitting Antenna Mode Indication Circuit, Simplified Schematic Diagram

However, the circuitry of the receiving antenna indicators is somewhat different. As shown on figure 7-16, 28 VDC in the acquisition data console is connected to the arm of auxiliary cable wrap switch S204 on the receiving antenna pedestal. When the receiving antenna passes the mid-point of its azimuth travel going in a clockwise direction, cable wrap switch S204 connects 28 VDC to north cable wrap indicator DS6037. When the receiving antenna passes its azimuth-travel mid-point in the counterclockwise direction, switch S204 connects 28 VDC to south cable wrap indicator DS6038. In contrast to the active acquisition aid cable wrap indicator circuit, the circuit which provides receiving antenna cable wrap indications to the acquisition data console is electrically independent of the cable wrap indication circuit on the antenna servo rack.

10. The transmitting antenna operating mode is indicated by "SLAVED" indicators DS6033 and DS6034 and "MANUAL" indicators DS6035 and DS6036. These mode indicators and "CABLE WRAP" indicators DS6039 and DS6040 are operated in the same manner as the corresponding indicators for the receiving antenna.

11. The operating mode of the Verlort radar is indicated by "VALID TRACK" indicators DS6009 and DS6010, "SLAVED" indicators DS6013 and DS6014, and "MANUAL" indicators DS6015 and DS6016. (See figures 7-1, 7-16, and 7-17.) One side of the "SLAVED" and "MANUAL" indicators is grounded in the console, and they are lit when 28 VDC is applied through mode switching relays in the radar. The Verlort "VALID TRACK" indicators are connected to the console 28 VDC supply through the C sections of power supply switches S6006 and S6007. The indicators are lit when ground is applied to them through the radar mode switch. This arrangement is necessary for proper operation of data processing equipment which is connected in parallel with the console "VALID TRACK" indicator,

but does not affect operation of the console indicator. Verlort valid track indicators in the FPS-16 radar and in the radar data selector (part of the site radar data processing equipment) are connected in parallel with the console "VALID TRACK" indicator, as shown on figure 7-1 and 7-17. Hence, a Verlort valid track indication appears in the FPS-16 and the radar data selector at the same time that it appears in the console.

12. The "VALID TRACK" indication from the FPS-16 is supplied to the Verlort and the radar data selector, as well as to the acquisition data console. (See figure 7-1, 7-16, and 7-17.) The three operating mode indicators connected to FPS-16 radar are "VALID TRACK" (DS6019, DS6020), "SLAVED" (DS6023, DS6024), and "MANUAL" (DS6025, DS6026). They are operated in the same manner as the corresponding indicators associated with the Verlort radar.

(b). <u>SYNCHRO CIRCUITS (Figures 7-1 and 7-7 through 7-15)</u>

There are six pairs of synchro receivers and one pair of synchro transmitters on the acquisition data console. (For a description of the principles of operation of synchros, refer to paragraph 4-2. E.) One of each pair handles azimuth data and the other elevation data.

1. Azimuth and elevation display data from the active acquisition aid comes into the acquisition data console by way of terminal board TB6005. From there it goes to synchro receivers B6001 (azimuth) and B6002 (elevation), where it is displayed. Position data from the active acquisition aid comes into terminal board TB6006 and goes from there to the contacts of relay K6003, where it is available for switching onto the acquisition bus. As shown on figure 7-7, the position data from the active acquisition aid comes from synchro (control) transmitters B205 and B305 in the active acquisition aid pedestal. The display data comes from synchro transmitters B202 and B302. In addition to going to the acquisition data console, the data from B202 and B302 goes to the active acquisition aid

control console, where it is displayed by synchro receivers B1201 and B1202.

2. Azimuth and elevation display data from the Verlort radar comes into the acquisition data console on terminal board TB6013. From there it is routed through TB6027, the contacts of relay K6010, TB6028, synchro line amplifier number 1, and TB6002 to synchro receivers B6003 (azimuth) and B6004 (elevation), where it is displayed. The purpose of relay K6010 is to protect the display receivers (B6003 and B6004) in the acquisition data console and the display data transmitters in the Verlort radar in the event that synchro reference voltage is not applied to the synchros in the console, but is applied to the synchros in the radar. (With reference voltage applied to one of two synchros connected together but not applied to the other, excessive stator currents flow and both of the synchros are likely to be damaged. Relay K6010 is energized by console synchro reference voltage; thus, when synchro reference voltage is not applied to the console, K6010 is de-energized and the stator circuits of B6003 and B6004 are disconnected from the radar. Position data from the Verlort radar does not come into the acquisition data console for switching, but it put onto the acquisition bus at the radar by actuation of the Verlort radar control relay.

3. The synchro circuit connections between the Verlort radar and the acquisition data console are shown on figure 7-9. Display data from synchro transmitters on the radar antenna pedestal comes through terminal boards TB34723 and TB34721 in the radar junction box and jack J11 in the external connector panel. Position data comes through J32 on the external connector panel, through the radar control relay when it is energized; and through J11 on the external connector panel. (For a complete description of the operation of the Verlort radar control relay, refer to paragraph 4-2. B. (4). (d).) Slaving data on the acquisition bus is connected to the Verlort radar through jack J11 in

the external connector panel, the normally-closed contacts of the radar control relay, and through synchro line amplifier number 6 to terminal board TB34749 in the radar junction box.

4. Display data from the FPS-16 radar comes into the console on terminal board TB6017. It goes through TB6029, the contacts of relay K6011, TB6030, synchro line amplifier number 2, and to synchro receivers B6005 (azimuth) and B6006 (elevation), where it is displayed. Like K6010, described in the previous paragraph, K6011 is a protective relay. As in the case of the Verlort radar, position data from the FPS-16 does not come into the acquisition data console for switching, but it put onto the acquisition bus at the radar by actuation of the FPS-16 radar control relay.

5. The synchro circuit connections between the FPS-16 and the acquisition data console are shown on figure 7-11. The FPS-16 data switch, through which all acquisition system synchro data to and from the FPS-16 passes, switches FPS-16 input and output data between Mercury and non-Mercury equipment which is external to the radar. Relays K1 through K4 (and others not shown on figure 7-11) in the data switch unit are energized at all times during Mercury operations. Relay K11 is the FPS-16 radar control relay. Display data from synchro transmitters on the FPS-16 antenna pedestal comes from terminal boards TB18026 and TB18027 in the radar data junction box, through relays K2 and K3 in the data switch unit, and to the acquisition data console. Position data from the radar comes from terminal boards TB18023 and TB18024 in the data junction box, through relays K1 and K2 in the data switch unit, and through the radar control relay K11 (when closed) in the data switch unit to the acquisition bus. (Refer to paragraph 4-2. B. (4). (d). for a complete description of the radar control relay.) Acquisition bus data for slaving the radar is connected through relays K3 and K4 of the data switch unit to terminal boards TB18011 and TB18013 in the data junction box. An interlock circuit prevents

the FPS-16 from being slaved to the acquisition bus when it is the source of the data on the bus.

6. Data from the receiving antenna comes into the console on TB6014 and goes from there to synchro receivers B6007 (azimuth) and B6008 (elevation) for display. As shown on figure 7-12, this data originates at synchro display transmitters B202 (azimuth) and B302 (elevation) on the receiving antenna pedestal. At the receiving antenna servo rack the acquisition bus data comes into the azimuth and elevation "LOCAL-REMOTE" switches, S102 and S101, in the receiving antenna servo rack. When the "LOCAL-REMOTE" switches are in the "REMOTE" position, the data from the acquisition bus is connected to control transformers B203 and B303 for slaving the antenna.

7. Data from the transmitting antenna comes into the acquisition data console on TB6019. From there it goes through synchro line amplifier number 3 and TB6015 to synchro receivers B6009 (azimuth) and B6010 (elevation) for display. As shown on figure 7-13, this data originates at synchro display transmitters B202 (azimuth) and B302 (elevation) on the transmitting antenna pedestal. At the transmitting antenna servo rack, the acquisition bus data comes into synchro line amplifier number 7. From the synchro line amplifier, the data is supplied to the azimuth and elevation "LOCAL-REMOTE" switches, S102 and S101, in the transmitting antenna servo rack. When the "LOCAL-REMOTE" switches are in the "REMOTE" position, the data from the acquisition bus is connected to control transformers B203 and B303 for slaving the antenna. Acquisition bus data is also supplied to synchro line amplifier number 8 (in the PMR Van) for slaving the antenna associated with the PMR Van.

8. The manual input to the acquisition bus is made by means of synchro transmitters B6015 and B6016 — B6015 for elevation and B6016 for azimuth data. The output of these synchro transmitters is available at relay K6004 for switching onto the

acquisition bus and is also wired directly to manual display synchro receivers B6014 (elevation) and B6013 (azimuth). Note that the S1-S3 connections from the manual synchro transmitters to the manual display receivers and to the acquisition bus are reversed. This reversed condition is necessary to obtain the proper output from the manual synchro transmitters because of a direction reversal that occurs in the gearing between the transmitter handwheels and the transmitters. To set data into the manual synchro transmitters, the console operator turns the transmitter handwheels and observes the manual receiver displays. There is no dial on the handwheels or the transmitters themselves to indicate their position.

9. Reference voltage for all of the synchros on the console is supplied from transformer T6001. Note that the synchro reference voltage circuit is separate from the 115 VAC which provides primary power for the console 28 VDC power supply and the synchro line amplifiers in the console.

(c). <u>DATA SWITCHING (Figure 7-1)</u>

The switching of data onto the acquisition bus from one of the four sources available (manual input, active acquisition aid, Verlort radar, and FPS-16 radar), is controlled by switches S6001, S6002, S6003, and S6005. These switches (and switches S6006 and S6007 associated with the 28 VDC power supply) are switch assemblies of the type described in paragraph 4-2. B. (3). and illustrated in figure 4-5.

1. Switch S6001 is the active acquisition aid "SOURCE" switch. When the plunger of S6001 is depressed, 28 VDC from the console d-c bus is applied through the common contact of section S6001D to the switch holding coil and through section S6001C to indicator lamps DS6007 and DS6008. The lamps are lit, and the holding coil, which is grounded through the common and normally-closed contacts of S6002B, S6003C, and S6005B, is energized. The action of the coil holds the plunger of S6001 in its depressed position. The common and normally-closed contacts of section

S6001D are in series with the 28 VDC supply to the other source switches; thus, when the plunger of S6001 is depressed, the 28 VDC supply to S6002 through S6005 is interrupted, and whichever (if any) of them had previously been energized is de-energized. With switch S6001 closed (plunger depressed), 28 VDC is supplied through the common and normally-open contacts of section S6001C to the coil of relay K6003, energizing this relay and connecting position data from the active acquisition aid to the acquisition bus.

2. Also with S6001 closed, 28 VDC is supplied through the common and normally-open contacts of section S6001C to terminal 8 of terminal board TB6007. This terminal is connected to the acquisition bus "AAA" mode indicator in the radars. (See figure 7-17.) Thus, when S6001 is closed, there is an indication in the radars that data from the active acquisition aid is on the acquisition bus.

3. The common and normally-closed contacts of sections A and B of S6001 are in series with portions of the mode control circuits in the active acquisition aid. When S6001 is actuated, the active acquisition aid cannot be slaved to the data on the acquisition bus. This arrangement prevents the active acquisition aid from being slaved to data for which it is the source. The pertinent portions of the active acquisition aid mode control circuits are shown on figure 7-18. For the active acquisition aid to be slaved to the acquisition bus, switch S67608 on the control console switch panel assembly is momentarily depressed. If the interlocks on the acquisition data console are closed (switch S6001 not actuated), the depressing of S67608 applies 28 VDC from the field and relay power supply in the servo cabinet through TB87504-2 to the coils of relay K1151 and the azimuth and elevation mode control relays shown on figure 7-18. The energizing of these relays puts the active acquisition aid into the slaved mode of operation. Since switch S67608 is a momentary type, a holding circuit is required to keep K1151 and

the mode control relays energized after S67608 is released. In the holding circuit, 28 VDC is supplied to the coils of the relays from TB87504-7 through normally-closed contacts of S67606, the interlock on the acquisition data console (S6001A), normally-closed contacts of S67607, and normally-open contacts 7 and 5 of K1151. Hence, when switch S6001 on the acquisition data console is actuated, the normally-closed contacts of section B prevent the active acquisition aid from being switched into the slaved mode, and the normally-closed contacts of section A of S6001 prevent the active acquisition aid from staying in the slaved mode even if it was already in that mode when S6001 was actuated.

4. Switch S6002 is the Verlort radar "SOURCE" switch. When the plunger of this switch is depressed, the common and normally-closed contacts of section B are opened, thus breaking the circuit of the holding coil of switch S6001. If switch S6001 had previously been energized, it is now de-energized, and 28 VDC is applied through the common to the normally-open contacts of sections D and C of S6002. The 28 VDC through section D is applied to the holding coil of S6002, and the 28 VDC through section C is applied to indicator lamps DS6017 and DS6018, which then light. The coil of S6002 is grounded through S6003C and S6005B; when energized it holds the plunger of S6002 in the actuated position. When S6002 is closed, 28 VDC through the common and normally-open contact of section C is also applied through TB6003-6 to the coil of the Verlort radar control relay (in the radar). The Verlort radar control relay is energized, putting data from the radar onto the acquisition bus. The common and normally-closed contacts of S6002D are in series with the 28 VDC supply to switches S6003 and S6005; hence, when S6002 is actuated, the 28 VDC supply to switches S6003 and S6005 is interrupted, and if either of them had been energized, it is now de-energized. The common and normally-closed contacts of section A of S6002 are in series with the slaving control

circuits in the Verlort. When S6002 is actuated, the Verlort cannot be slaved to the acquisition bus. (The radar control relay in the Verlort duplicates this interlocking function. It is wired in such a manner that it inherently prevents the Verlort from being slaved to its own synchro output. Refer to paragraph 4-2. B. (4). (d).

5. Switch S6003 is the FPS-16 radar "SOURCE" switch. When the plunger of this switch is depressed, the common and normally-closed contacts of section C are opened, thus breaking the circuit of the holding coils of switches S6001 and S6002. If either of these switches had been energized, it is now de-energized, and 28 VDC is applied through the common to the normally-open contact of section D of S6003. This 28 VDC is then applied to the holding coil of S6003 and to indicator lamps DS6027 and DS6028. These indicator lamps and the coil of S6003 are grounded through the normally-open and common contacts of S6003C. Hence, the lamps are lit and the coil is energized. When energized, the coil holds the plunger of S6003 in the actuated position. The 28 VDC on the normally-open contact of section D, in addition to being applied to the indicator lamps and switch coil, is applied through terminal TB6003-3 to the coil of the FPS-16 radar control relay, energizing this relay and putting position data from the FPS-16 on the acquisition bus. The common and normally-closed contacts of S6003D are in series with the 28 VDC supply to switch S6005, so that when S6003 is actuated, the 28 VDC supply to S6005 is interrupted, and if it had been energized, it is now de-energized. The common and normally-open contacts of S6003 sections B and A are connected to slaving control circuits in the FPS-16 radar in such a manner that when S6003 is actuated, the FPS-16 cannot be slaved to the acquisition bus. Thus, the FPS-16 is prevented from being slaved to the output of its own synchros. The connections of this interlock circuit between the acquisition data console and the FPS-16 are shown on figure 7-20.

6. Switch S6005 is the manual "SOURCE" switch. Section B of this switch is in series with the holding coils of switches S6001 through S6003. When S6005 is actuated (plunger depressed), the holding coil circuits of S6001 through S6003 are opened, de-energizing whichever (if any) of these switches had been energized. Twenty-eight volts d-c is applied through the normally-open contacts of S6005A and S6005D to the holding coil of the switch and to indicator lamps DS6047 and DS6048. The lamps are lit, and the coil is energized, holding the switch plunger in the actuated position. The 28 VDC on the normally-open contact of S6005C is applied to the coil of relay K6004 and terminal 7 of TB6007. Relay K6004 is energized and manual input data is connected to the acquisition bus. The 28 VDC on TB6007-7 is applied to the "MANUAL" indicators in the radars; when S6005 is closed, there is an indication in the radars that data from the acquisition data console manual input is on the acquisition bus. The interconnecting circuits for this manual indication between the radar site acquisition data console and the Verlort and FPS-16 radars are shown in figure 7-17.

7. "NO DATA ON BUS" indicators DS6049 and DS6050 are supplied with 28 VDC in series with the common and normally-closed contacts of the D sections of S6001 through S6003 and S6005. The indicator lamps are lit as long as the console 28 VDC power supply is on and none of the four source switches has been actuated; when any one of them is actuated, the "NO DATA ON BUS" indicator lamps are out.

8. As described in the preceding paragraphs, switches S6001, S6002, S6003, and S6005 are electrically interlocked; when any one of them is actuated by depressing the plunger, d-c power to the coils of all the others is interrupted. If two or more are actuated at the same time (which should never happen), they open each other's circuits; neither holding coil is energized, and only the one electrically nearer the 28 VDC supply connects data to the bus. For example, if S6001 and S6005 both happened to be

depressed at the same time, the depressing of S6005 would have no effect since the 28 VDC to it would be interrupted by the depressing of S6001. Since 28 VDC would be applied to S6001, relay K6003 would be energized and data from the active acquisition aid would be put on the acquisition bus. However, the holding coil circuit of S6001 would be opened by the depressing of S6005, and S6001 would not remain depressed when it was released.

9. When the dual power supply on the console is first turned on, none of the "SOURCE" switches is actuated. After any one of them has been actuated, or turned on, they all can be de-energized, or turned off, only by turning off the dual power supply with switch S6201 (on the front of the dual power supply panel).

(d). <u>RADAR CONTROL RELAYS</u>

1. The manner in which the Verlort control relay connects the Verlort radar to the acquisition bus is shown in simplified form on figure 4-9. When the relay is not energized, data on the acquisition bus is connected through the common and normally - closed contacts of the relay to synchro line amplifier number 6 and thence to the slaving input circuits (remote data input of the radar. Thus, with the control relay unenergized the Verlort may, at the option of the Verlort operator, be slaved to the acquisition bus. The radar control relay is energized by the application of 28 VDC from switch S6002 on the acquisition data console. This switch is shown in simplified form on figure 4-9 as part of the data source selector. When the relay is energized the input to the radar is disconnected from the acquisition bus, and the position data output of the radar is connected. The radar control relay is mounted on the master-slave relay panel in the Verlort van. A complete schematic of the relay panel and the connecting circuit is shown on figure 7-9.

2. The manner in which the FPS-16 radar control relay connects data from the FPS-16 to the acquisition bus is shown in

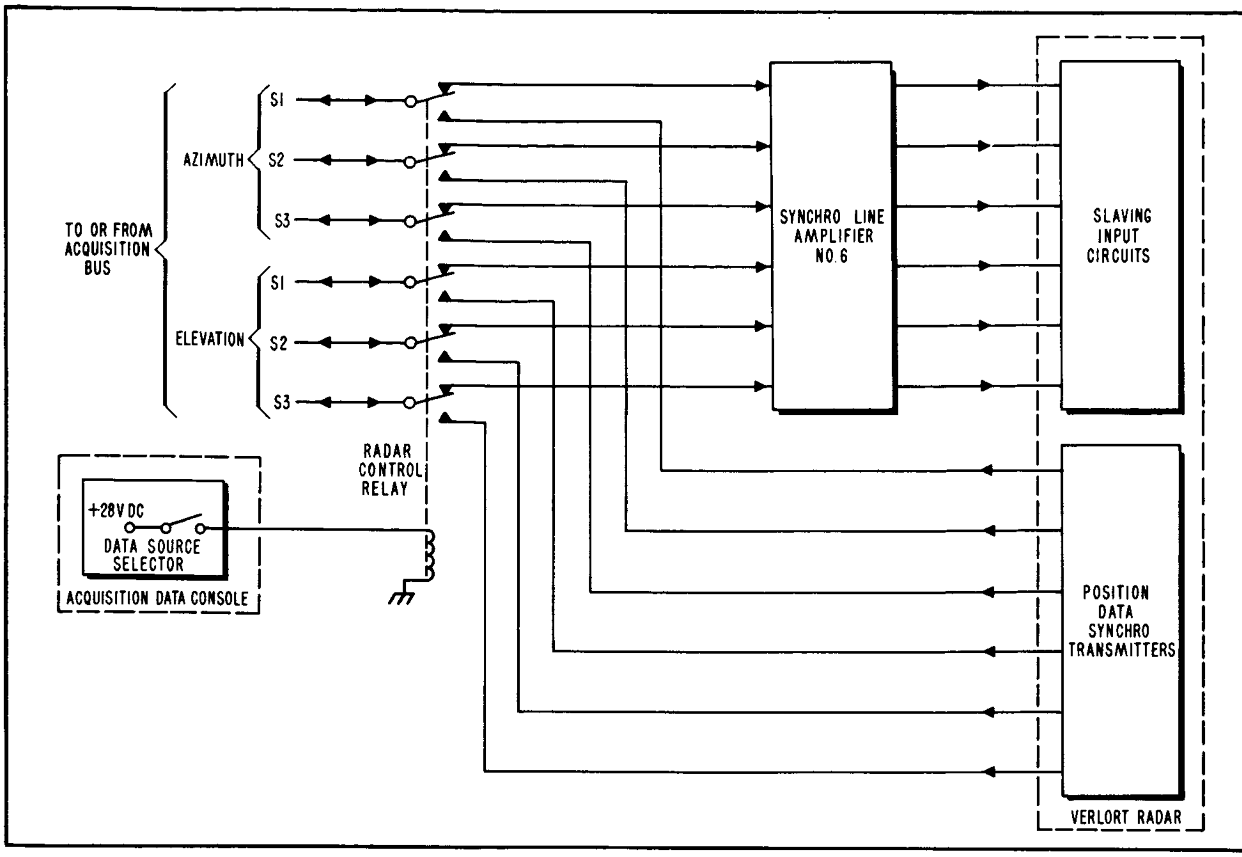


Figure 4-9. Verlort Radar Control Relay Circuit, Simplified Schematic Diagram

simplified form on figure 4-10. When the relay is energized, the position data output of the radar is connected to the acquisition bus. Unlike the arrangement provided by the Verlort radar control relay circuit, the acquisition bus data is available at the FPS-16 slaving input circuits even when the FPS-16 control relay is energized. Therefore, an interlock circuit is used (refer to paragraph 4-2. B. (4). (c). 5.) to prevent the FPS-16 from being slaved to its own output. The FPS-16 radar control relay is energized by the application of 28 VDC from switch S6003 on the acquisition data console. The switch is shown in simplified form on figure 4-10. The control relay is in the data switch unit in the FPS-16 building. Figure 7-11 shows the complete circuit of the control relay (K11) in the data switch unit. It

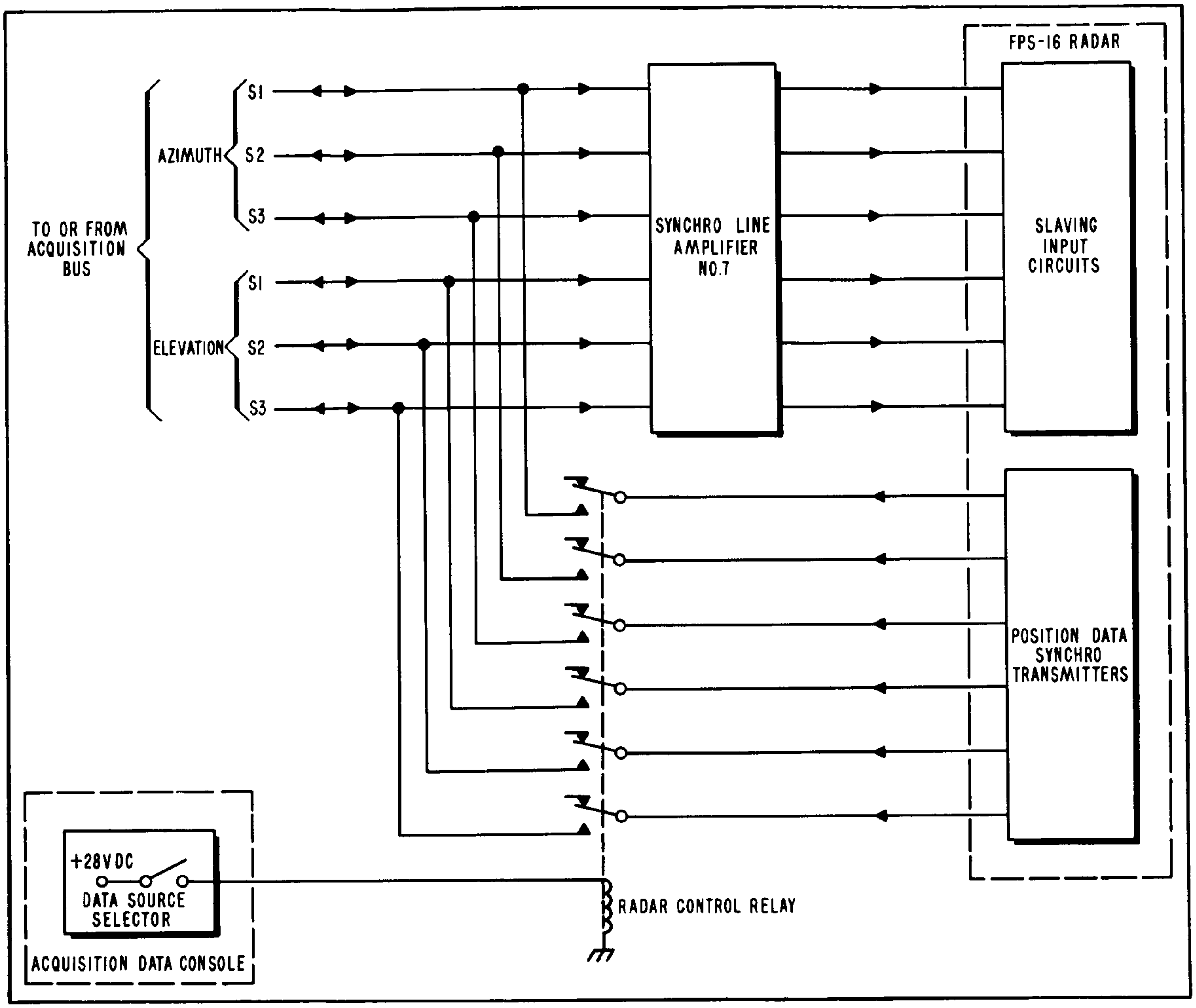


Figure 4-10. FPS-16 Radar Control Relay Circuit, Simplified Schematic Diagram

should be noted that the other relays shown on figure 7-11 are energized at all time during Mercury operations and are not used in the switching of data onto the acquisition bus.

C. ACTIVE ACQUISITION AID

(1). GENERAL

(a). One of the problems associated with the use of narrow-beam, precision-tracking radars is the acquisition of a small, high-speed target. The problem is due simply to the fact that the target passes through the radar beam so quickly that the radar and/or operators have very little time in which to recognize the target and switch into automatic tracking. The problem is solved by the use of the active acquisition aid, which has a wide antenna pattern (20 degrees), but tracks with accuracy (within ±0.5 degrees) sufficient to point a narrow-beam radar at the target.

(b). The relative cones of coverage of the radar and the active acquisition aid are represented in figure 4-11. The active acquisition aid cone of coverage on the illustration does not represent an actual beam since the active acquisition aid has no transmitter; instead, it represents a receiving antenna pattern.

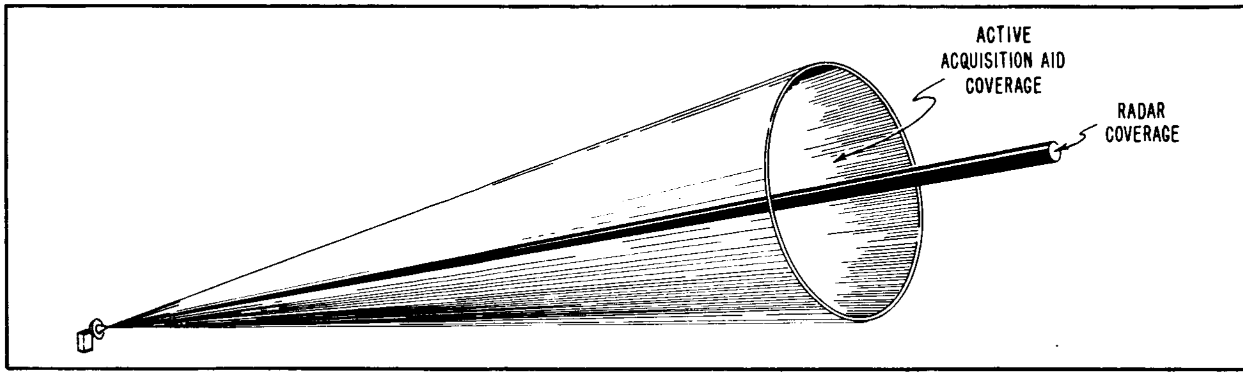


Figure 4-11. Relative Coverage by Active Acquisition Aid and Radar

Because of its wide cone of coverage, the active acquisition aid does not require precise antenna pointing in order to acquire its target, the Mercury capsule. The antenna is pointed in accordance with the best data available. For initial acquisition, as the capsule comes over the radio horizon, this data is based on computations of the capsule's orbit. For re-acquisition in the event automatic tracking is lost during a pass of the capsule, the best data is in most cases simply an estimate based on the capsule's position when the track was lost. As soon as the capsule comes within its 20-degree cone of coverage, the active acquisition aid acquires an automatic track and steers itself to boresight; i.e., it points its antenna so that the capsule is in the center of its cone of coverage. Position data (capsule azimuth and elevation) is then put out by the active acquisition aid and at the acquisition data console is switched onto the acquisition bus. The radars are slaved to this data and are therefore pointed at the capsule. The active acquisition aid continues to track the capsule, and each radar remains slaved until it acquires the capsule and begins independent, automatic tracking. This, then, is the first primary function of the active acquisition aid: to acquire and track the capsule in azimuth and elevation and provide data which enables the radars to acquire the capsule.

(c). The second primary function of the active acquisition aid is to provide pointing data to the non-tracking antennas on the site. After it acquires the capsule, the active acquisition aid continues automatic tracking until the capsule is out of range. The non-tracking antennas are normally slaved through the acquisition system to the radar, but before the radar acquires the capsule or when for any other reason data from the radar is not available, the non-tracking antennas are slaved to the active acquisition aid.

(d). A secondary function of the active acquisition aid is to receive HF voice, UHF voice, and telemetry signals. HF voice signals are received by an HF dipole and reflector which are mounted on the active acquisition aid antenna. The received HF signals are fed directly to HF voice receiver number 1. Telemetry and UHF voice signals are separated from the telemetry by the triplexer and fed to a UHF voice preamplifier (part of the capsule communications system). The two telemetry frequencies go through two stages of r-f amplification in the active acquisition aid and then are fed out to telemetering system equipment.

(2). BLOCK DIAGRAM DESCRIPTION (Figure 4-12)

(a). The active acquisition aid quad-helix antenna receives two telemetry signals transmitted by the capsule. These signals (at

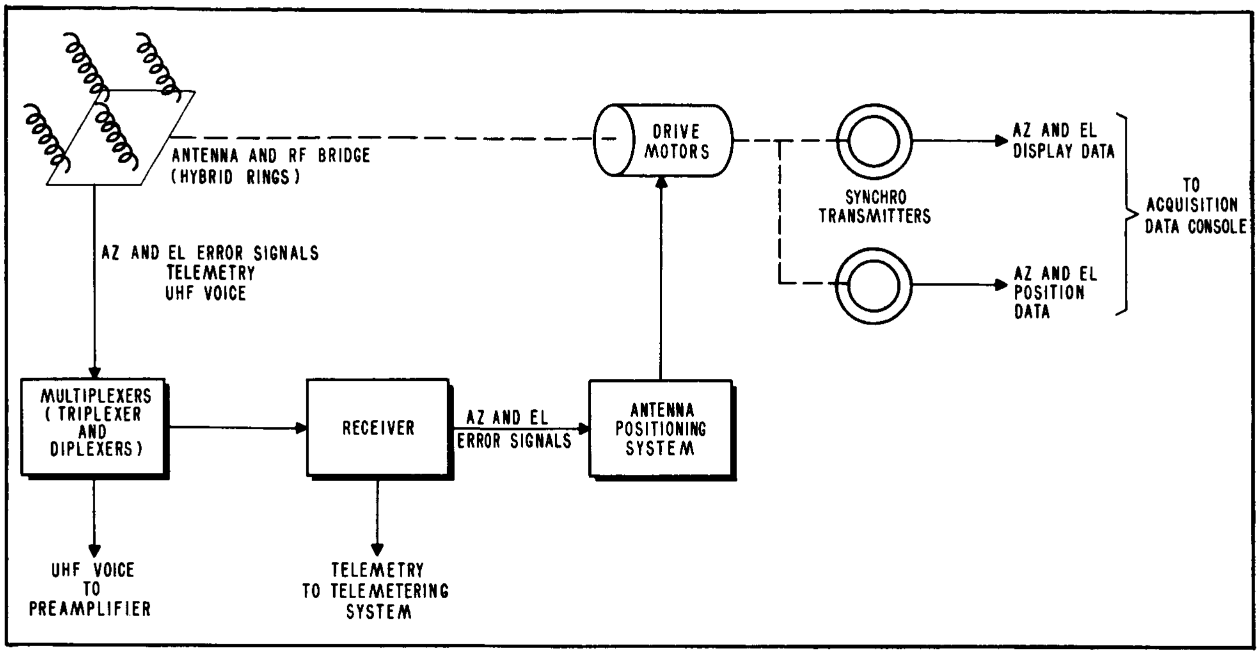


Figure 4-12. Active Acquisition Aid, Simplified Block Diagram

frequencies T1 and T2, or A and B) are fed from the helical antenna elements to an r-f bridge composed of the four hybrid rings. For each frequency, three outputs from the r-f bridge are used. These outputs are reference signal (vectorial sum of the signals from the four antenna elements), a signal (azimuth error) which depends on the azimuth displacement of the antenna from boresight, and a signal (elevation error) which depends on the elevation displacement of the antenna from boresight. The derivation of the azimuth and elevation error signals is based on a phase comparison in the r-f bridge of the signals from the antenna elements. When the antenna is off boresight in azimuth, the signals from the two elements on the right side of the antenna differ in phase from the signals from the two elements on the left side; when the antenna is off boresight in elevation, the signals from the two top elements differ in phase from the signals from the two bottom elements. Comparison of these phases yields the error signals.

(b). The azimuth and elevation error signals and the reference signal are fed from the r-f bridge through the triplexer and diplexers, for frequency separation, to the receiver. The first and second r-f amplifiers and the first mixer and i-f amplifier of the receiver are in the RF housing unit. The balance of the receiver circuits are in the receiver cabinet. The receiver locks onto one or the other of the telemetry frequencies, as selected by switch.

(c). The output of the receiver consists of azimuth and elevation error signals to the antenna positioning system. The antenna positioning system comprises, in essence, electronic and electro-mechanical servo amplifiers and antenna drive motors. This system continuously positions the antenna for minimum, or null, error signals out of the receiver. Thus, the antenna is kept pointing at the target which is being tracked.

(d). Two pairs of synchro transmitters are mechanically coupled to the antenna. One of these pairs transmits antenna azimuth and elevation position data to the acquisition bus. The other pair transmits azimuth and elevation display data for display on the active acquisition aid control console and on the acquisition data console. The position data transmitters provide the principal output of the active acquisition aid system; these transmitters are the means by which acquisition and tracking information is sent to other equipment.

(e). On the meter and switch panel of the control console, there are azimuth and elevation error meters which permit manual tracking with the active acquisition aid in the event that part of the automatic system is inoperative or when it is not desired to use fully automatic tracking. These meters indicate the amount and direction of antenna pointing error. (The errors indicated by the meters are essentially the same as those supplied to the antenna positioning system during fully automatic tracking.) For manual tracking with the error meters the operator simply turns the manual handwheels on the control console to null the error indicated on the meters.

(f). Manual pointing of the antenna for maximum strength of received signals can be performed with the aid of signal strength meters on the active acquisition aid control console. There are five of these meters; four on the signal strength meter panel and one on the meter and switch panel. The four on the signal strength meter panel indicate the strength of the signals received by the four telemetry receivers on the site. Two of the receivers are connected to the active acquisition aid antenna, and the signal received by them is, of course, maximum when the active acquisition aid antenna is pointing at the capsule. The other two telemetry receivers are connected to the receiving antenna. The fifth meter, the one on the meter and switch panel, indicates the strength of the signal in the sum channel of the active acquisition aid. The five meters continuously indicate the strength of the signal received by their respective receivers. Audio (telemetry video) also can be monitored, but from only one receiver at a time, as selected by switch (see figure 4-13). As shown on figure 4-13, when a receiver is selected for audio monitoring, a pilot lamp adjacent to the signal strength meter for that receiver is lit, providing a direct indication of which receiver has been selected. Thus, the signal strength indication and the audio being monitored are correlated. The audio output may be either from a speaker, as shown on figure 4-13, or from an earphone connected to jacks on the console audio amplifier. The complete circuit, including connections to the telemetry equipment, is shown on figure 7-21.

(g). For manual tracking by means of received signal strength, the receiver is selected which provides the best signal strength indication and audio. When the selected receiver is the active acquisition aid itself or one of two telemetry receivers connected to its antenna, the operator simply turns the handwheels on the console for maximum signal strength as indicated on the appropriate meter. Monitoring of the audio insures that a telemetry signal and not just noise is being received. When one of the telemetry receivers connected to the receiving antenna is selected, the receiving antenna must be slaved through the acquisition system to the active acquisition aid. Then, turning the handhweels on the active acquisition aid control console positions the receiving antenna. Under this condition, the active acquisition aid operator turns the handwheels, and thereby remotely positions the receiving antenna for maximum signal indication from the selected receiver.

D. SYNCHRO LINE AMPLIFIER

A block diagram of a synchro line amplifier and the manner in which it is connected into the system is shown in figure 4-14. The azimuth and elevation synchro transmitters shown on the illustration represent the transmitters at whatever source is connected to the synchro line amplifier, and the azimuth and elevation receivers on the illustration represent whatever receivers are connected to the synchro line amplifier. (For the transmitters and receivers connected to each synchro line amplifier, see the system block diagram, figure 4-1.) In both the azimuth and elevation channels, which are identical, the S2 stator windings are directly connected. The S1-S2 stator voltage and the S2-S3 stator voltage are amplified by amplifier elements with the S2 winding being the common (chassis ground) connection in both cases. (Each amplifier element consists of a voltage amplifier, a phase splitter, a push-pull cathode follower driver, and a push-pull power amplifier.) With this arrangement, a third amplifier element is not necessary for the S1-S3 voltage; the S1-S3 voltage is taken across the output of the two amplifier elements. The output of the amplifier elements in the synchro line amplifier is reversed 180 degrees in phase from the input. To compensate for this reversal, the R1 and R2 rotor leads are reversed between the synchro transmitters and the receivers, or, in some cases, the synchro receivers are electrically turned 180 degrees without interchanging the R1 and R2 connections. (Refer to Section V.) For a complete discussion of the theory of operation of the synchro line amplifier, refer to the applicable equipment manual, listed in table 1-II.

E. SYNCHROS

(1). TRANSMITTERS AND RECEIVERS

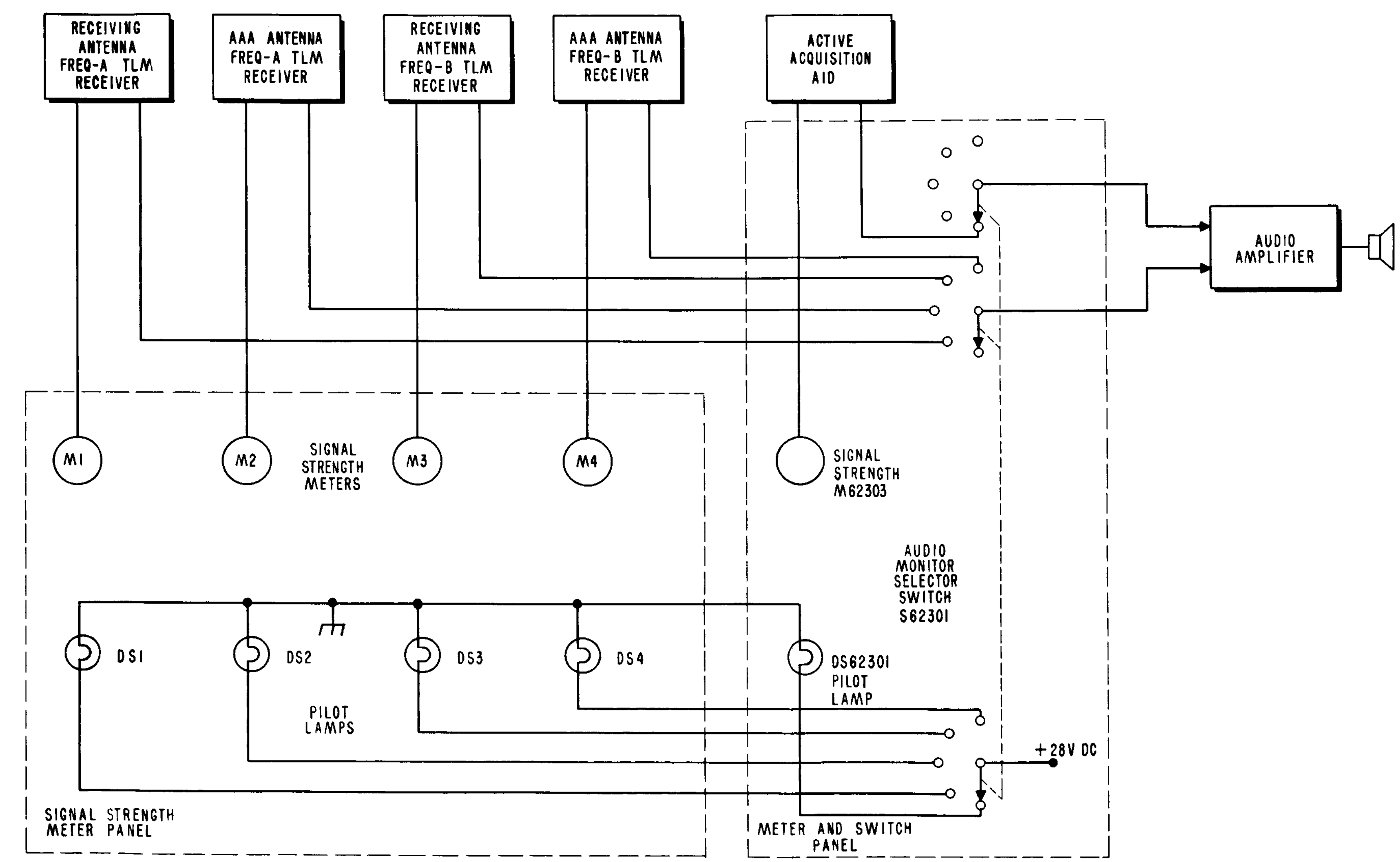


Figure 4-13. Signal Strength Indicating Circuits, Simplified Schematic Diagram

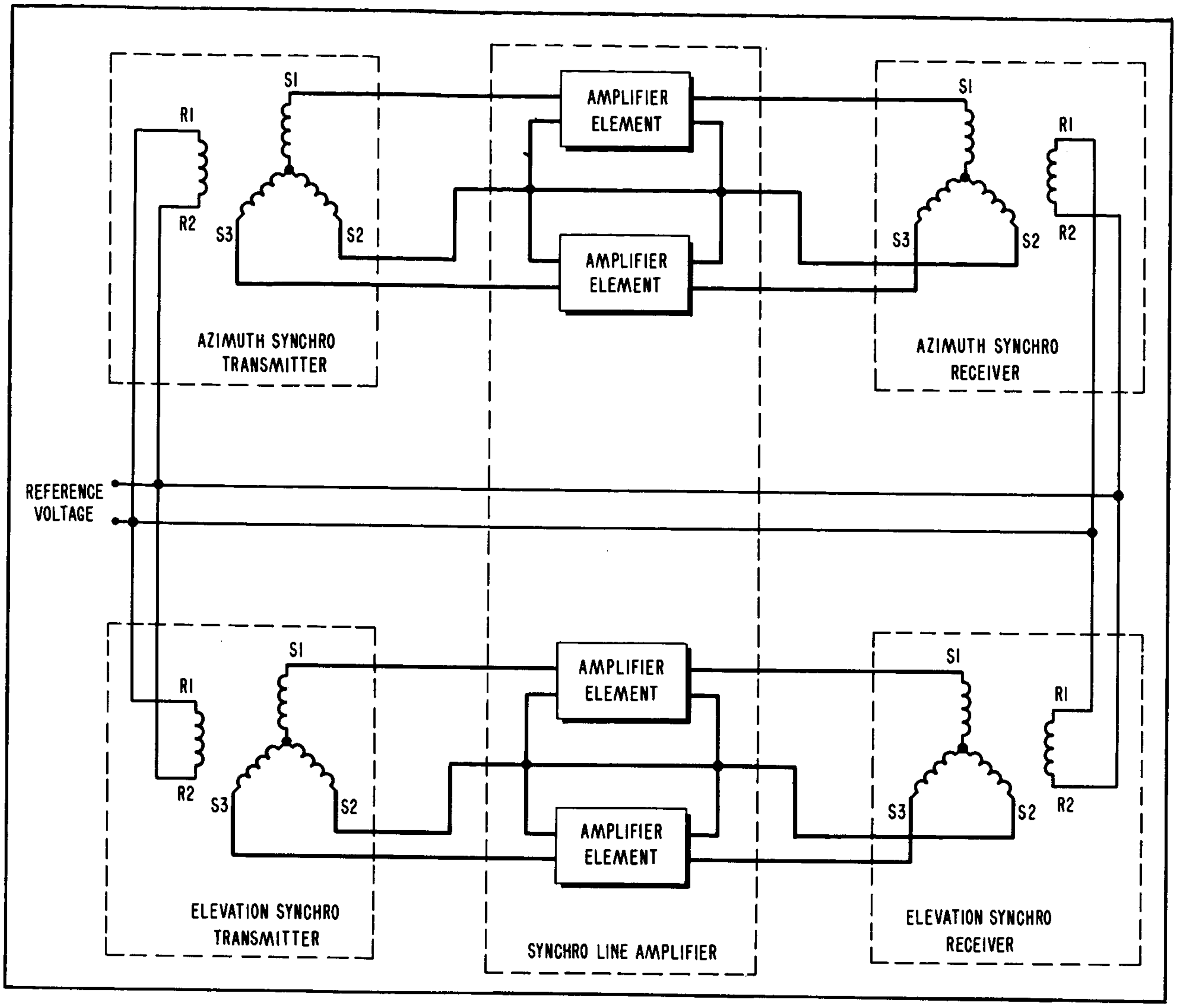


Figure 4-14. Synchro Line Amplifier, Block Diagram

(a). A standard synchro transmitter or receiver, such as is used in the acquisition system, may be considered as a single-phase transformer with a rotatable primary and a stationary, wye-wound secondary. Accordingly, the primary winding is called the rotor, and the secondary windings are called the stator. The two terminals of the rotor windings are designated R1 and R2, and the terminals of the three stator windings are designated S1, S2, and S3.

(b). A reference, or excitation voltage (115 VAC, 60 cycles for the synchro in the acquisition system) is applied to the rotor of a synchro.

(See figure 4-15.) This reference voltage applied to the rotor of the synchro induces voltages in the stator windings. The magnitude of the voltage induced in a given stator winding depends on the angle which the rotor makes with that stator winding, and the phase angle of the voltage in a stator winding with respect to the rotor voltage is always zero or 180 degrees. The voltages in the windings of a synchro stator are shown in figure 4-16. The curves in the illustration are plots of the voltage magnitudes and phase against the angle of the rotor. The voltage across each stator winding (i.e., from the winding terminal to the common connection of the three windings) varies from 52 VAC (rms) of one phase polarity through zero to 52 VAC of the opposite phase polarity as the rotor is turned. Due to the way the rotor and stator windings are arranged on a synchro, these curves are sinusoidal. However, they should not be confused with timegraphs of sinusoidal voltages. All of the voltages in a synchro system are a-c, they are either in phase or 180 degrees out of phase with each other, and their effective (rms) values vary with the angle of the rotor, as shown on the illustration.

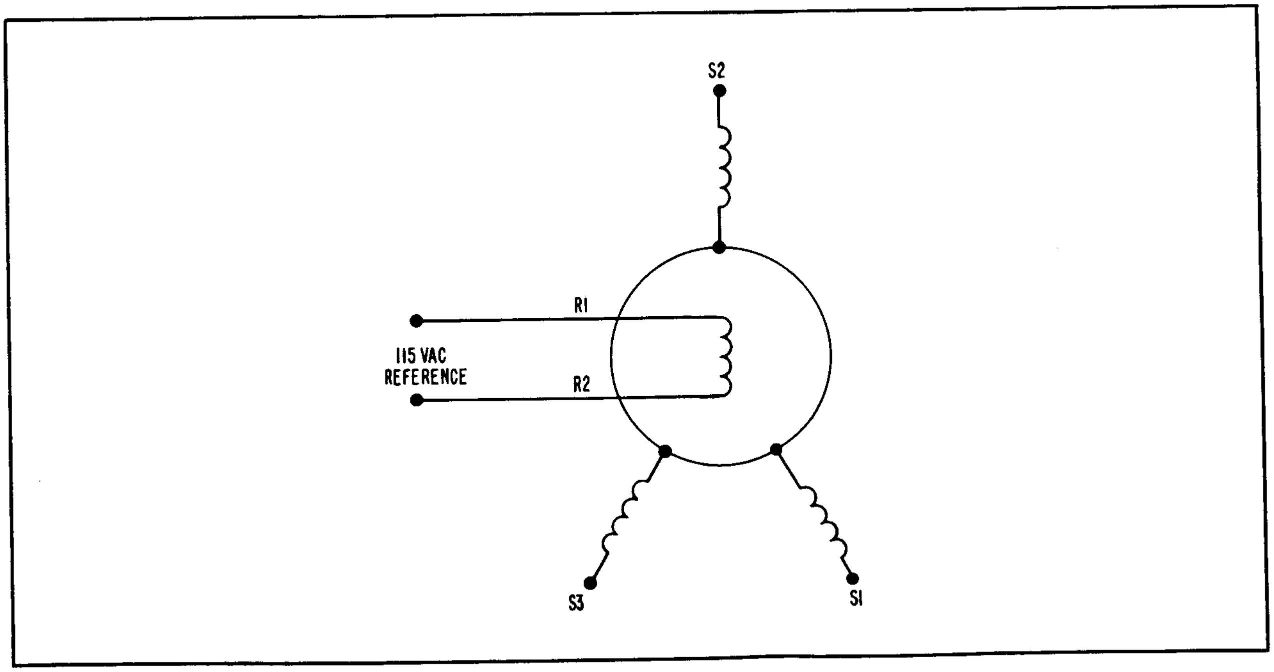


Figure 4-15. Synchro Transmitter or Receiver, Schematic Diagram

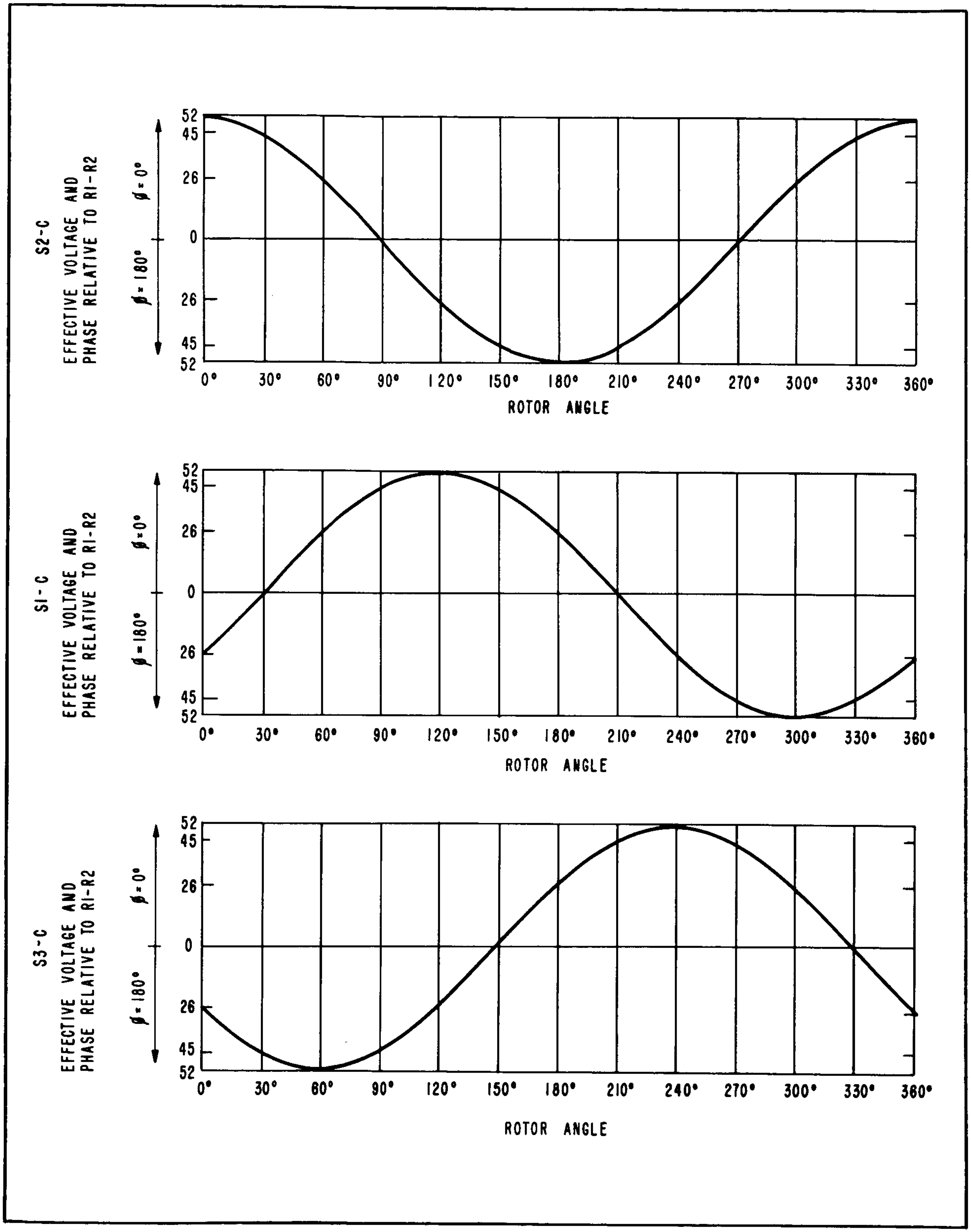


Figure 4-16. Voltages in Synchro Stator Windings

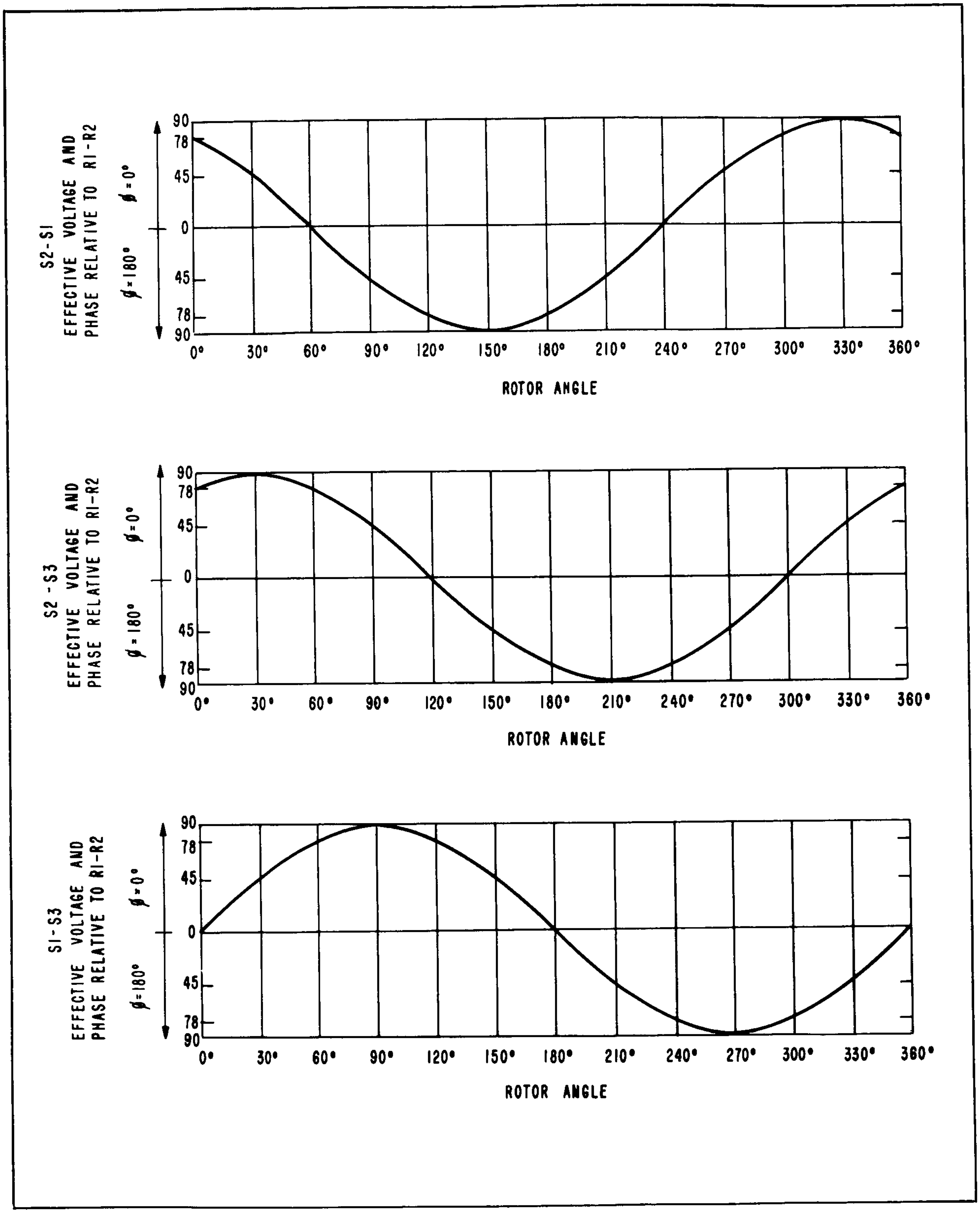


Figure 4-17. Voltages between Synchro Stator Windings

(c). In practice, no external connection is made to the common connection of the three stator windings, and the synchro system stator voltages are taken between the three pairs of windings: S2 and S1, S2 and S3, and S1 and S3. The voltage magnitude and phase between these pairs of windings is shown in figure 4-17 for varying rotor angles.

(d). The simplest form of synchro system consists of a transmitter and a receiver. A transmitter and a receiver which are suitable for use in the same system generally are electrically identical, but differ somewhat mechanically. The most notable mechanical difference is the use of a damper on the receiver in order to prevent it from oscillating. The transmitter, being mechanically coupled to an antenna or handwheel through a gear train, requires no damper. Hence, if mechanical coupling can be arranged, a receiver can be used as a transmitter, but a transmitter generally cannot be used as a receiver.

(e). The manner in which a synchro system works is illustrated in figures 4-18 and 4-19. The stator windings of the transmitter are connected to the corresponding windings on the receiver; S1 to S1, S2 to S2, and S3 to S3. The rotor windings of the transmitter and receiver are connected in parallel and are supplied by 115 VAC reference.

NOTE

> All of the rotor windings in a synchro system must be connected to a common reference voltage source. Otherwise, phase differences between voltage sources will cause inaccuracies in the system.

With the reference voltage applied and both of the rotors at zero degrees, as shown in figure 4-18, voltages in the stator windings are 52 VAC for the S2 windings and 26 VAC each for the S1 and S3 windings. The arrows on the illustration adjacent to the windings indicate relative instantaneous current direction (relative phase). As can be seen from figure 4-18, with both the transmitter and receiver rotors at the zero position, the magnitudes of the voltages induced in the

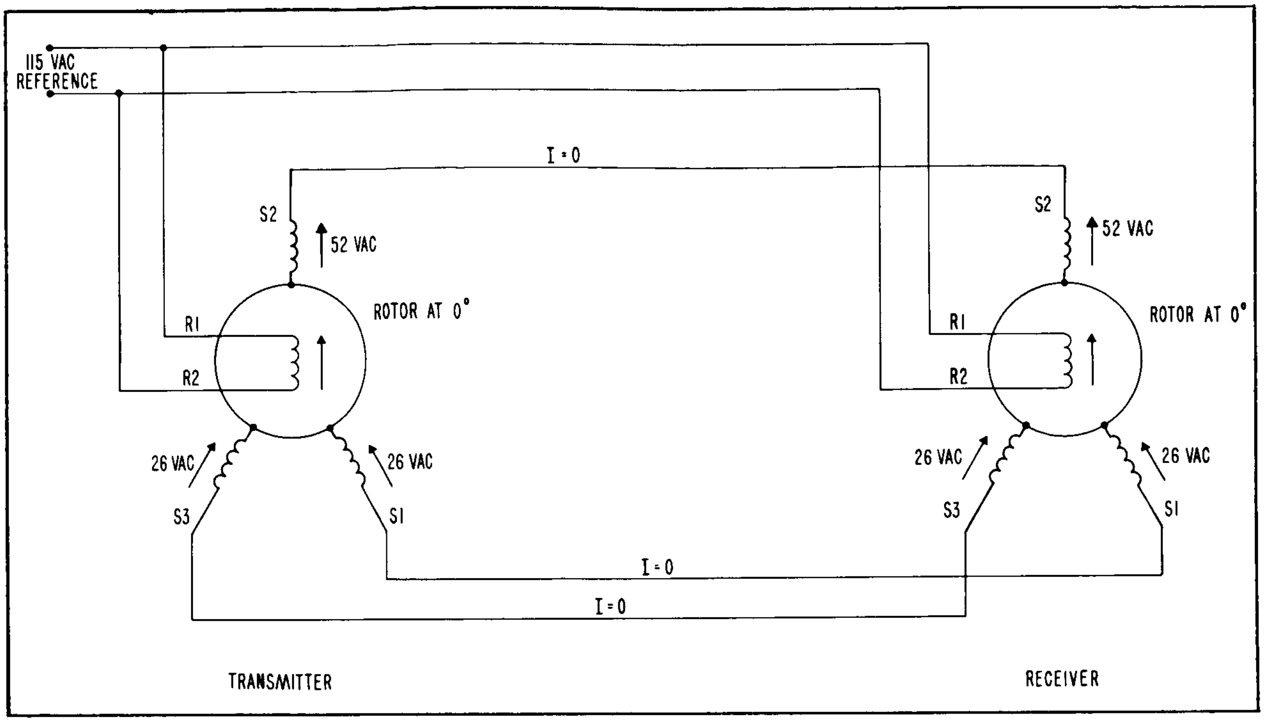


Figure 4-18. Simple Synchro System with Transmitter and Receiver Rotors at the Same Position, Schematic Diagram

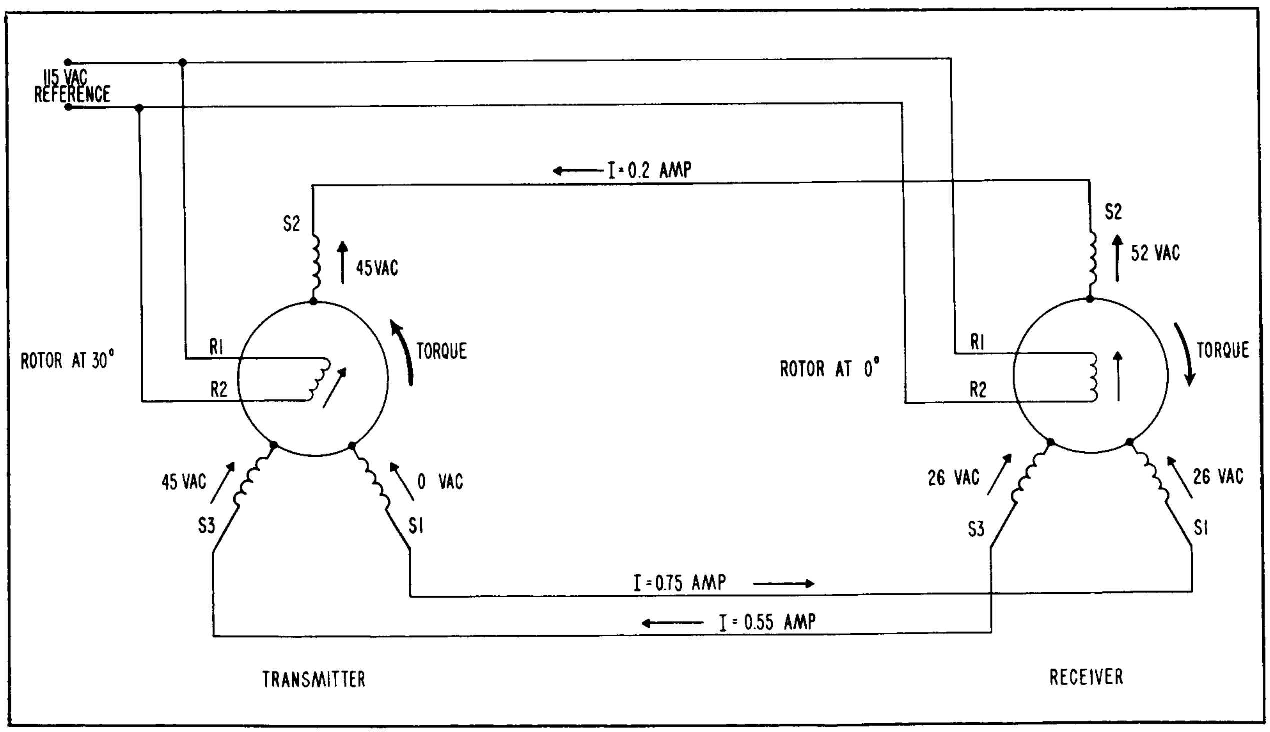


Figure 4-19. Simple Synchro System with Transmitter and Receiver Rotors at Different Positions, Schematic Diagram

stator windings of the transmitter and receiver are the same, and the phases are such that no current flows through the windings. With no current in the windings, no torque is developed and both synchros remain at rest. This condition of dynamic balance (voltages and phases such that no current flows in the stator windings) exists whenever, but only so long as, the rotors of the transmitter and receiver are at the same angular position.

(f). If the synchro receiver is held at one position and the transmitter turned to another position, unbalanced stator voltages are developed and current flows in the windings. An example of this condition is shown in figure 4-19. The rotor of the transmitter is turned to 30 degrees, inducing stator voltages of the magnitudes and relative phases as shown on the illustration. (For the magnitude and relative phase of the induced stator voltages at any position of the rotor, see figure 4-16.) The rotor of the receiver, however, is at a different position, zero degrees, and the voltages induced in its stator windings are different from those in the stator of the transmitter. Currents with the relative phases shown flow in the stator windings. The magnitudes indicated for the currents are typical values. These currents cause torque to be applied to the rotors of the synchro and both of the rotors try to turn. Under the conditions shown on figure 4-19, the transmitter rotor will try to turn in a counterclockwise direction and the receiver rotor in a clockwise direction. The transmitter rotor, when it is mechanically coupled to an antenna or a handwheel, is not free to turn, but the receiver rotor is free to turn. Thus, the receiver rotor turns to the same position as the transmitter rotor and the system comes to dynamic rest. In the same manner, if the transmitter rotor is turned to some new position, the receiver rotor follows. The synchros used in the acquisition system have sufficient sensitivity that as long as reference voltage is applied and the units are operating normally, a receiver will always follow the transmitter to which it is connected within a small fraction of a degree; the receiver is always at virtually the same position as the transmitter, regardless of whether the transmitter is stationary or is being turned. Hence, a pointer or dial attached to the receiver rotor provides an indication of the angular position of the device — in most cases an antenna — to which the transmitter rotor is coupled.

(g). Either a single receiver or several receivers in parallel may be driven by a single transmitter. The acquisition system employs both of these arrangements.

(h). A variety of nomenclature is applied to synchros. The most common of these are listed and explained below:

1. Torque receiver (TR): a synchro receiver.
2. Torque transmitter (TX): a synchro transmitter which can drive a relatively large mechanical load (on the receiver or receivers connected to the transmitter).
3. Control transmitter (CX): a synchro transmitter which can drive only a relatively small mechanical load (on the receiver or receivers connected to the transmitter).

NOTE

Both torque transmitters and control transmitters are synchro transmitters as described in the previous paragraphs, and except for the amount of load they can drive, they are the same.

4. Synchro generator: a synchro transmitter.
5. Synchro motor: a synchro receiver.
6. Control transformer (CT): this device is described in the following paragraph.
7. Selsyn, autosyn: trade names for synchros.

(2). CONTROL TRANSFORMERS

(a). The control transformer is a type of synchro unit widely used in automatic control systems. Its function is to supply an a-c voltage whose magnitude and phase polarity depend on the difference between the angular position of its rotor and the rotor of the synchro transmitter which is connected to it. Control transformers are used in various places in the antenna positioning systems which are part of or are connected to the acquisition system.

(b). Control transformers are similar to synchro transmitters and receivers, but differ from them in several important respects:

1. The rotor winding of a control transformer is never connected to an a-c supply and therefore induces no voltage in the stator windings. As a result, the stator current is determined only by the impedance of the windings, which is high, and it is not appreciably affected by the rotor's position. (A matched set of delta-connected capacitors is connected across the stator leads near the control transformer. These capacitors correct the lagging power factor of control transformer coils and reduce the current drawn from the synchro transmitter.) Also, there is no appreciable current in the rotor, and the rotor does not tend to turn to any particular position, when voltages are applied to the stator. The rotor of a control transformer is always turned by some mechanical device such as antenna. (Or more specifically, by gearing between an antenna and the control transformer.)

2. The zero position of a control transformer is that at which the rotor is at right angles to the S2 stator winding. (See figure 4-20.) Note that this zero position differs by 90 degrees from that of a transmitter or receiver (figure 4-18).

(c). The manner in which a control transformer is connected in a system is shown in figure 4-21. The stator windings of the control transformer are connected to the corresponding stator windings of a synchro transmitter. The rotor of the control transformer is usually connected to a servo amplifier. With a reference voltage (115 VAC) applied to the rotor of the transmitter, voltages are induced in the stator windings of the transmitter. These voltages are representative, by magnitude and phase polarity, of the angular position of the rotor. Since the stators of the control transformer and transmitter are connected, currents flow in the windings, and if the control transformer rotor is at any position except the same as or 180 degrees different from that of the transmitter rotor, voltage is induced in the control transformer rotor.

(d). The voltage induced in the control transformer rotor when it is at a position different from the transmitter rotor depends in magnitude and phase polarity on the angular difference between the two rotors. The voltage variation for 360 degrees of angular difference between the positions of the two rotors is shown on figure 4-22. Note that the rotor voltage has two null points: at positions which are zero and 180 degrees different from the position of the transmitter rotor. When the control transformer rotor is between zero and 180 degrees relative to the transmitter rotor (voltage curve above zero line on figure 4-22), the control transformer rotor voltage is of one phase; between 180 and 360 degrees (voltage curve below the line on figure 4-22), it is of the opposite phase.

(e). For a description of how control transformers are used, refer to paragraph 4-2. F.

F. TYPICAL SERVO SYSTEMS UTILIZING SYNCHROS

In the acquisition system and the equipment associated with it there are a number of servo systems which utilize synchros. A simplified version of a servo system of this type is described in this paragraph in order to provide basic understanding of how mechanical position data is converted to electrical form, transmitted over a distance, and converted back to mechanical form. Figure 4-23 illustrates such a system.

(1). The prinicpal elements of the system are a mechanical input (the handwheel on figure 4-23), a mechanical/electrical converter (the synchro transmitter) an electrical/mechanical converter (the servo loop consisting of the control transformer, the servo amplifier, and the servo motor), and a mechanical output, or load (the antenna).

(2). The output of the synchro transmitter is a function of the position of its rotor, which is mechanically coupled to the handwheel. The output of the synchro transmitter is connected to the control transformer, whose rotor may or may not be at the same angular position as that of the transmitter. Refer to paragraph 4-2. E. for

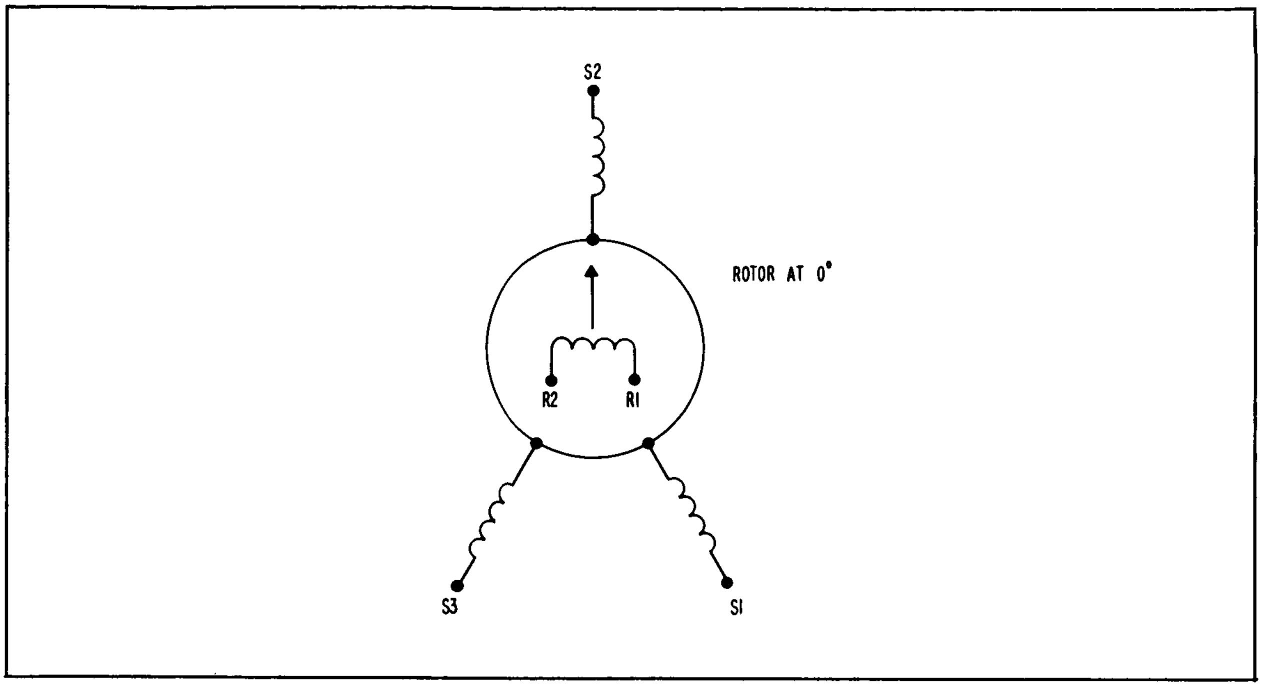


Figure 4-20. Control Transformer, Schematic Diagram

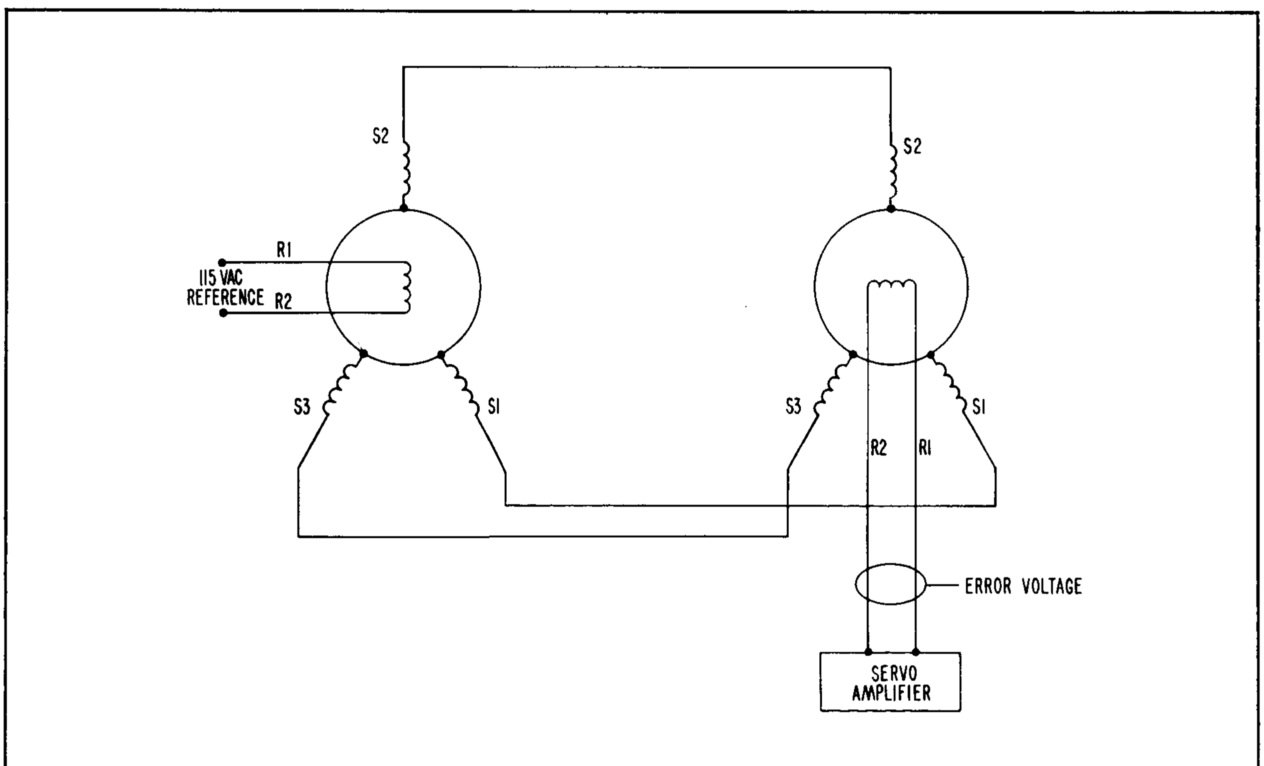


Figure 4-21. Control Transformer and Synchro Transmitter Connections, Schematic Diagram

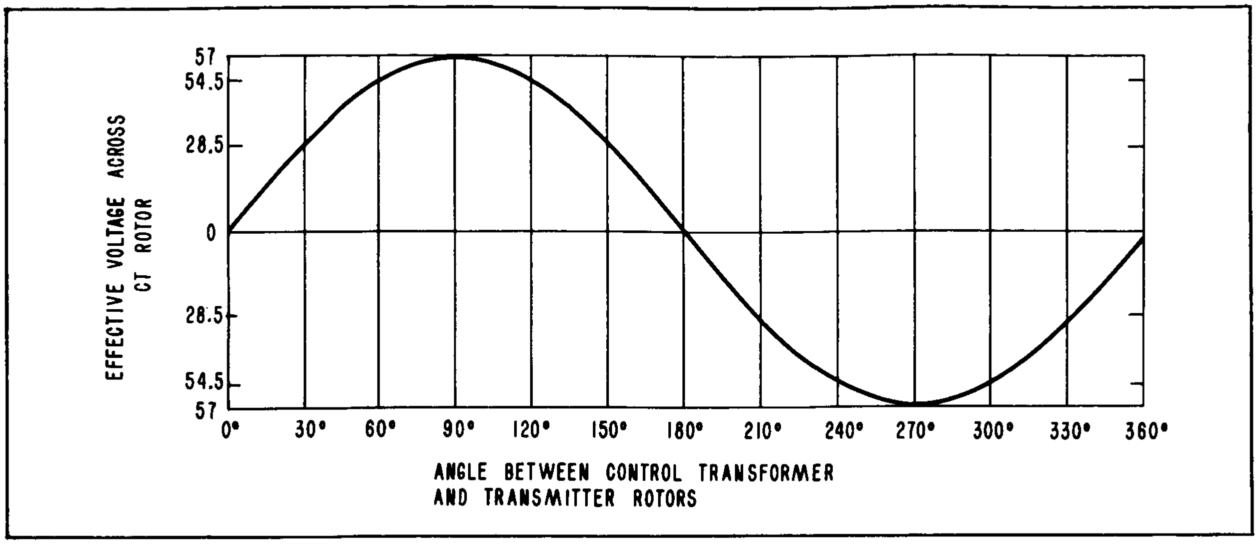


Figure 4-22. Voltages in Rotor Winding of Control Transformer

a description of the operation of synchro transmitters and control transformers. When the control transformer rotor is not at the same position as the rotor of the transmitter, a voltage is developed in the control transformer rotor windings. The magnitude and phase polarity of this voltage depend on the angular difference between the positions of the two rotors. This voltage, the error signal of the servo loop, is applied to the servo amplifier, where it is amplified and applied to the variable-phase field winding of a two-phase motor. A reference voltage is applied to the fixed-phase field of the rotor. The direction of rotation of the motor depends on the phase of the error signal (relative to the reference voltage), and the speed of rotation of the motor depends on the magnitude of the error signal. When no error signal is applied, the motor does not rotate. The motor armature is coupled through gearing to the rotor of the control transformer and to the mechanical load, in this case an antenna. The gearing and phase of signals in the servo loop are so arranged that whenever there is an error signal developed across the rotor of the control transformer, the motor turns in the direction which results in a reduction of the magnitude of the error. Stated another way, the motor drives the rotor of the control transformer so that it is always at very nearly the same position as the rotor of the synchro transmitter. Since the antenna is also driven by the motor, it too is kept at virtually the same position as the transmitter rotor. Thus, the antenna follows the handwheel which turns the synchro transmitter rotor.

(3). The servo systems actually used in the acquisition system and associated equipment are generally more elaborate than that just described, but the principal elements of the systems are the same. For instance, the active acquisition aid uses an amplidyne and a d-c servo motor in each channel of its antenna positioning system. The d-c servo motor, however, has exactly the same basic function as the two-phase, a-c motor on figure 4-23, and the amplidyne, is in its function, simply an additional two-stage servo amplifier.

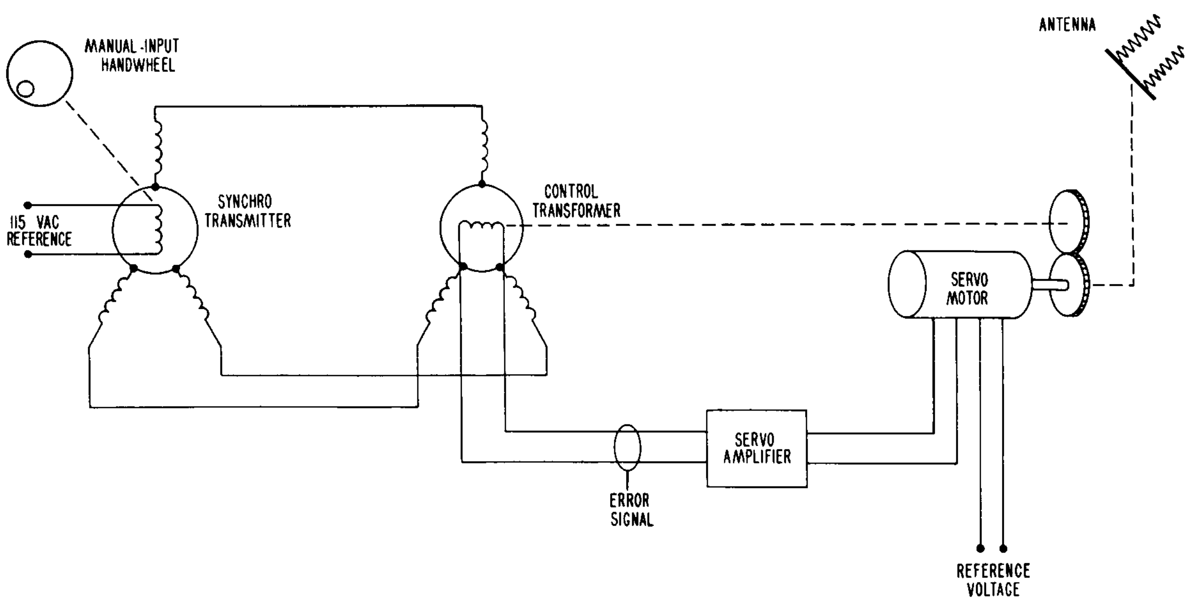


Figure 4-23. Typical Servo System Utilizing Synchros, Simplified Schematic Diagram

SECTION V
SYSTEM MAINTENANCE

5-1. GENERAL

This section includes information, instructions and procedures for preventive maintenance, trouble shooting, adjustments and repair, lubrication, special tools, and test equipment. Detailed information is given only for the acquisition data console and its components; for other equipment in the system, system-level and general information is given. For detailed information on the other equipment in the system, refer to the applicable equipment manuals, listed in table 1-II.

WARNING

Antenna drive power cutoff switches and warning lights are mounted below the platforms of the active acquisition aid, the receiving antenna, and the transmitting antennas. (Refer to Section II for the location of the switches.) When drive power is applied to the pedestal, the warning light is lit. The switch should be turned off (thus removing drive power from the pedestal) before going onto the antenna platform for maintenance or repair. For a schematic diagram of the active acquisition aid antenna safety circuit, which includes the cutoff switch and warning light, see figure 7-19.

5-2. PREVENTIVE MAINTENANCE

A. PREVENTIVE MAINTENANCE SCHEDULE

Table 5-I outlines the preventive maintenance procedures which are to be performed on all of the equipment in the acquisition system. Detailed procedures are discussed in paragraph 5-2.B. and the equipment manuals. For a list of equipment manuals and the equipment to which they apply, refer to table 1-II.

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE

Equipment	Maintenance To Be Performed	Refer To
	DAILY	
Active Acquisition Aid	Check cover plates on pedestal for watertightness.	Equipment manual
	Check all strip heaters for proper operation.	Equipment manual
	Check azimuth and elevation limit switches for proper operation.	Equipment manual
	Operate the pedestal both in azimuth and elevation for several minutes in order to keep the gearing well lubricated.	-
	WEEKLY	
All	Check for corrosion of painted and plated surfaces. Clean and resurface all corroded areas.	Paragraphs 5-2. B.(1). and (2).
	Check mechanical condition of switches to see that they are not loose or sluggish in their action. Replace any that appear likely to become defective.	-
All except Acquisition Data Console	Check the lamps or bulbs in all indicators. Replace any that are burned out.	Equipment manual
Acquisition Data Console	Check and replace any burned out lamps in the 28 VDC power supply indicators.	Paragraph 3-2. B.
	Check and replace any burned out lamps in the source switch indicators.	Paragraph 3-2. D.
	Check and replace any burned out lamps in all of the indicators not covered by the previous two steps.	Paragraph 3-5. A.

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	WEEKLY (Cont.)	
Active Acquisition Aid	Check for the presence of water in the azimuth oil sump.	Equipment manual
	Check for the presence of water in the elevation gear compartment.	Equipment manual
	Check the oil level in the azimuth oil reservoir.	Equipment manual
	MONTHLY	
All	Perform general cleaning as necessary. Wipe off, vacuum off, or blow out dust, dirt and sand. Clean dial plates (glass) on synchro displays.	-
	Check and correct as necessary the general condition of equipment. Check cables and wiring for worn or frayed insulation, check connectors to see that they are free from corrosion and are tight, and check terminal board connections for tightness.	-
Active Acquisition Aid	Check the operation of the azimuth oil pump.	Equipment manual
	Check the oil level in the elevation oil reservoir.	Equipment manual
	Check the cleanliness of the lubricants in the antenna control unit.	Equipment manual
	Check the azimuth and elevation drive motor breakaway currents.	Equipment manual
	Check the conditions, placement, and dress of cables which wrap as the pedestal turns.	Equipment manual

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	BIMONTHLY	
Active Acquisition Aid	Check the operation of the elevation oil pump.	Equipment manual
	Check the azimuth and elevation amplidyne and drive motor brushes and commutators.	Equipment manual
	Check the amount of backlash in the pedestal drive gearing.	Equipment manual
	SEMI-ANNUALLY	
Active Acquisition Aid	Check the mechanical friction of the pedestal (torque required for pedestal azimuth and elevation movement.)	Equipment manual
	YEARLY	
Active Acquisition Aid	Disassemble azimuth and elevation amplidynes and clean and lubricate bearings and air circulating system.	Equipment manual
	Disassemble azimuth and elevation drive motors and check the condition of the bearings.	Equipment manual

B. PREVENTIVE MAINTENANCE PROCEDURES

(1). PAINTED SURFACES

Painted surfaces which have corroded should be sanded to remove all of the corroded material and then painted with a color which matches the original. If matching paint is not available, apply any available paint. When matching paint is obtained, paint non-matching areas for the sake of appearance.

(2). PLATED SURFACES

Corrosion of plated surfaces (cadmium, nickel or other) should be removed with sandpaper or emery cloth and sprayed or brushed with a clear lacquer. If a clear lacquer is not available, the corroded areas should be painted to prevent further corrosion until lacquer can be obtained.

5-3. TROUBLE SHOOTING

This paragraph provides information to aid in the isolation and correction of troubles in the acquisition system. It is concerned primarily with those malfunctions which affect the transmission of acquisition information; for information on a malfunction which affects only an individual piece of data source or data-using equipment, refer to the applicable equipment manual. Since the d-c indication and synchro portions of the acquisition system are essentially independent of one another, they are treated separately in the following discussions.

A. D-C INDICATIONS

The d-c indication circuits in the acquisition system are simple and straightforward and should pose little difficulty in trouble shooting. When a d-c indicator fails to operate properly, refer to the diagrams in Section VII, (both the individual equipment schematics and the interconnecting circuit schematics) and to the applicable portions of paragraph 5-4 for information on isolating and ascertaining the source of trouble. The source of the trouble will in most instances, be obvious on examination of the circuits involved. For information on inter-equipment wiring, refer to Section II, and for information on the internal wiring of equipment other than the acquisition data console, refer to the applicable equipment manual.

B. SYNCHROS

This paragraph comprises three sections: criteria for distinguishing actual troubles (requiring repair or replacement to correct them) from those malfunctions which can be corrected by adjustment; system trouble analysis; and circuit trouble analysis. The material on system trouble analysis provides information to aid in isolating the trouble to a particular circuit, or portion of the system. The material on circuit trouble analysis will aid in further isolating and determining the exact nature of the trouble. Both the system and circuit trouble analyses are concerned with actual troubles, not misadjustments. For synchro adjustment procedures, refer to paragraph 5-4.B.

(1). <u>CRITERIA FOR DISTINGUISHING TROUBLE FROM MISADJUSTMENT</u>

A synchro device is not operating properly when it does not accurately, rapidly and smoothly transmit or follow the angular information which is fed into it. If a synchro has an error in the information it puts out, but the error is small and constant and the output of the synchro follows the input smoothly and rapidly, the cause of the improper operation is most likely misadjustment. (For a transmitter the input is mechanical and the output is electrical. For a receiver the input is electrical and the output mechanical. For a control transformer there are two inputs, one electrical and one mechanical, and one output, electrical.) If the synchro follows the input but with changing error, does not follow the input, spins, oscillates, hunts, follows erratically, has a large error (about 60 degrees or more), hums, overheats, or exhibits a combination of these or similar symptoms, the cause is most likely an actual trouble, either in the synchro being observed, another synchro connected to it, or the circuits between the two. (Improper adjustment of a synchro line amplifier however, will cause a varying error in the system which is not due to an actual trouble. The peak value of such error is dependent on the amount of amplifier output imbalance.)

(2). <u>SYSTEM TROUBLE ANALYSIS</u>

Trouble shooting of the synchros in the acquisition system requires a thorough knowledge of the basic principles of synchros and the particular way in which they are used in the system. (Refer to Section IV.) With this knowledge it should be evident from the pertinent schematics, especially figure 5-8 and the interconnecting circuit schematics in Section VII, what the possible causes are for any given trouble. However, keep the following points in mind:

(a). A defective synchro can degrade the performance or cause abnormal operation of any or all synchros which are connected directly to it; for instance, where two receivers (or a receiver and a control transformer) are wired in parallel, a defect in one of them may cause be as shown by the curves of figures 4-17. Control transformer rotor voltage should be as shown in figure 4-22.

5-4. ADJUSTMENTS AND REPAIR

A. GENERAL

This paragraph describes, on an individual basis, adjustment and repair procedures for synchros, the 28 VDC power supply, relays, and switch and indicator assemblies. Also described are adjustment procedures for the synchro line amplifier. For detailed information on other components of the acquisition system, see the applicable equipment manuals. The repair procedures given here are based on the assumption that a particular component, such as a relay, switch or synchro, is known or suspected to be malfunctioning. The procedures are for the isolation and correction of the specific cause of trouble. For general, or system, trouble shooting procedures, see paragraph 5-3.

B. SYNCHRO ALIGNMENT

(1). GENERAL

(a). This paragraph describes procedures for alignment and zeroing of synchro transmitters, receivers, and control transformers individually and while operating in a system. Also described are procedures for 180-degree reversal of synchro receivers.

(b). In a general sense, "zeroing" a synchro means adjusting it mechanically so that it will work properly in a system with one or more other synchros. Specifically, "zeroing" means aligning the mechanical and electrical zero positions of a synchro. Mechanical zero of a synchro is defined as the rotor position at which the mechanical device coupled to the synchro is at its zero position. For instance, a synchro transmitter coupled to the elevation drive of an antenna is at mechanical zero when the antenna is at zero degrees elevation; and a synchro receiver driving an azimuth indicator is at mechanical zero when the indicator pointer or dial reading is zero degrees azimuth. Electrical zero of a synchro is defined as the position of the rotor when rated voltage is applied to the rotor, when there is no voltage difference between S1 and S3, and when rated abnormal operation of both. In cases where several synchros have abnormal operation, it will help in isolating the trouble to disconnect, one at a time, each of those involved to see which is affecting the operation of the others.

(b). The reference voltage (rotor) circuits are virtually the only circuits the azimuth and elevation channels have in common. If abnormal operation shows up in both azimuth and elevation channels in a portion of the acquisition system, look for trouble in the reference voltage circuits.

(c). Troubles that show up just after installation or replacement of synchro units are most likely due to incorrect wiring connections, not to defective units.

(d). When a trouble occurs, be sure to check all connecting circuits very thoroughly. Synchros themselves, although delicate instruments, are generally very reliable and trouble-free devices.

(3). CIRCUIT TROUBLE ANALYSIS

Once it has been determined that the source of trouble is in a particular circuit or portion of the system, circuit trouble analysis may be performed by one or a combination of the following means:

(a). Use of the synchro trouble shooting chart, figure 5-1: This chart graphically shows the symptoms and causes of most of the common synchro troubles, including incorrect wiring connections.

(b). Checks of connecting circuits: All of the circuits between synchros in a malfunctioning portion of the system should be checked in accordance with the applicable portions of paragraph 5-4 and the applicable equipment manuals. Also see the interconnecting circuit schematic diagram in Section VII.

(c). Synchro voltage checks: In some instances it may not be possible to rotate the suspected synchros as is necessary when using figure 5-1. In such instances the synchro voltages can be checked. Transmitter and receiver rotor voltage should always be 115 VAC. Transmitter, receiver and control transformer stator voltages should amplifier reverses the phase of all synchro stator voltages which pass through it. With normal connections, synchro receivers connected to a line amplifier would give readings 180 degrees different from what they should; and the usual procedure for correcting a reverse synchro reading (interchanging the R1 and R2 connections) cannot be followed in all cases as it would result in a direct short circuit of the 115 VAC synchro reference voltage. The procedures given below of course take these conditions into account and except where noted are applicable to all synchros connected to the acquisition system.

(d). The procedures that follow comprise four sections; one for individual zeroing of transmitters, one for individual zeroing of receivers, one for individual zeroing of control transformers, and one for in-system alignment of transmitters and receivers. The first three sections apply, with some exceptions as noted, to any individual synchro transmitter, receiver, or control transformer in the acquisition system.

(2). SYNCHRO TRANSMITTERS

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous; i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. In practice, however, it is usually not necessary to follow the complete procedure. Once the transmitter has been installed and is operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). TRANSMITTER ZEROING PROCEDURE – COMPLETE

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).
2. Turn off reference voltage to the synchro (115 VAC).
3. Disconnect the stator leads (S1, S2, S3) from the synchro.

voltage is applied between S2 and S1-S3 in such a way that the voltage at S2 (measured with respect to S1-S3) is in phase with the voltage at R1 (measured with respect to R2). The applied voltages and the rotor position at electrical zero are shown in figure 5-2. The voltages shown are the rated values for the synchros used in the acquisition system. For purposes of definition, the arrangement shown in figure 5-2 applies both to synchro transmitters and receivers, and it is actually used for zeroing receivers. However, since synchro transmitters in operating position are not free to turn, a more convenient zeroing procedure is described below. The electrical zero position of a control transformer is as described in paragraph 4-2. E. (2). and shown in figure 4-20.

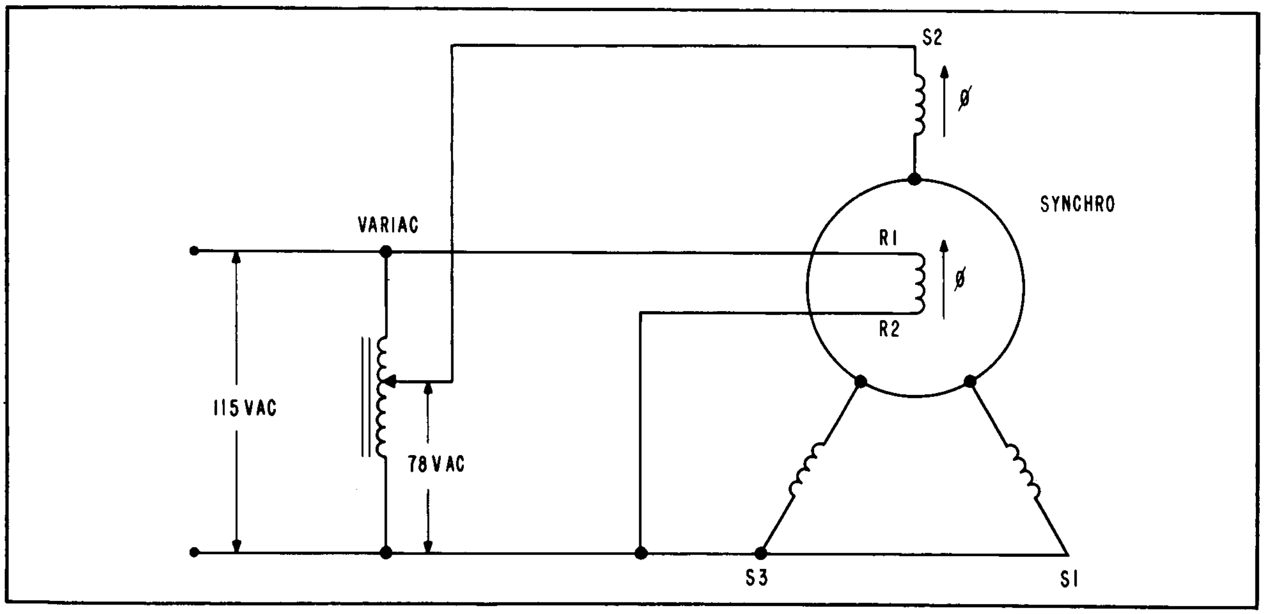


Figure 5-2. Conditions at Electrical Zero of a Synchro

(c). Certain of the synchro receivers used in the acquisition system require special procedures for zeroing. The requirement for special procedures derives from the fact that the R2 and S2 windings are internally connected in all synchros on the acquisition data console, that the S2 winding of all synchros connected to a synchro line amplifier is grounded within the amplifier, and that a synchro line amplifier reverses the phase of all synchro stator voltages which pass through it. With normal connections, synchro receivers connected to a line amplifier would give readings 180 degrees different from what they should; and the usual procedure for correcting a reverse synchro reading (interchanging the R1 and R2 connections) cannot be followed in all cases as it would result in a direct short circuit of the 115 VAC synchro reference voltage. The procedures given below of course take these conditions into account and except where noted are applicable to all synchros connected to the acquisition system.

(d). The procedures that follow comprise four sections; one for individual zeroing of transmitters, one for individual zeroing of receivers, one for individual zeroing of control transformers, and one for in-system alignment of transmitters and receivers. The first three sections apply, with some exceptions as noted, to any individual synchro transmitter, receiver, or control transformer in the acquisition system.

(2). <u>SYNCHRO TRANSMITTERS</u>

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous; i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. In practice, however, it is usually not necessary to follow the complete procedure. Once the transmitter has been installed and is operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). <u>TRANSMITTER ZEROING PROCEDURE — COMPLETE</u>

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).
2. Turn off reference voltage to the synchro (115 VAC).
3. Disconnect the stator leads (S1, S2, S3) from the synchro.

4. Connect a jumper between synchro terminals R2 and S2 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-3.)

CAUTION

Before connecting the jumper between R2 and S2, make sure that the synchro has no internal jumpers which, when the external jumper is connected, would result in a short circuit of the 115 VAC power.

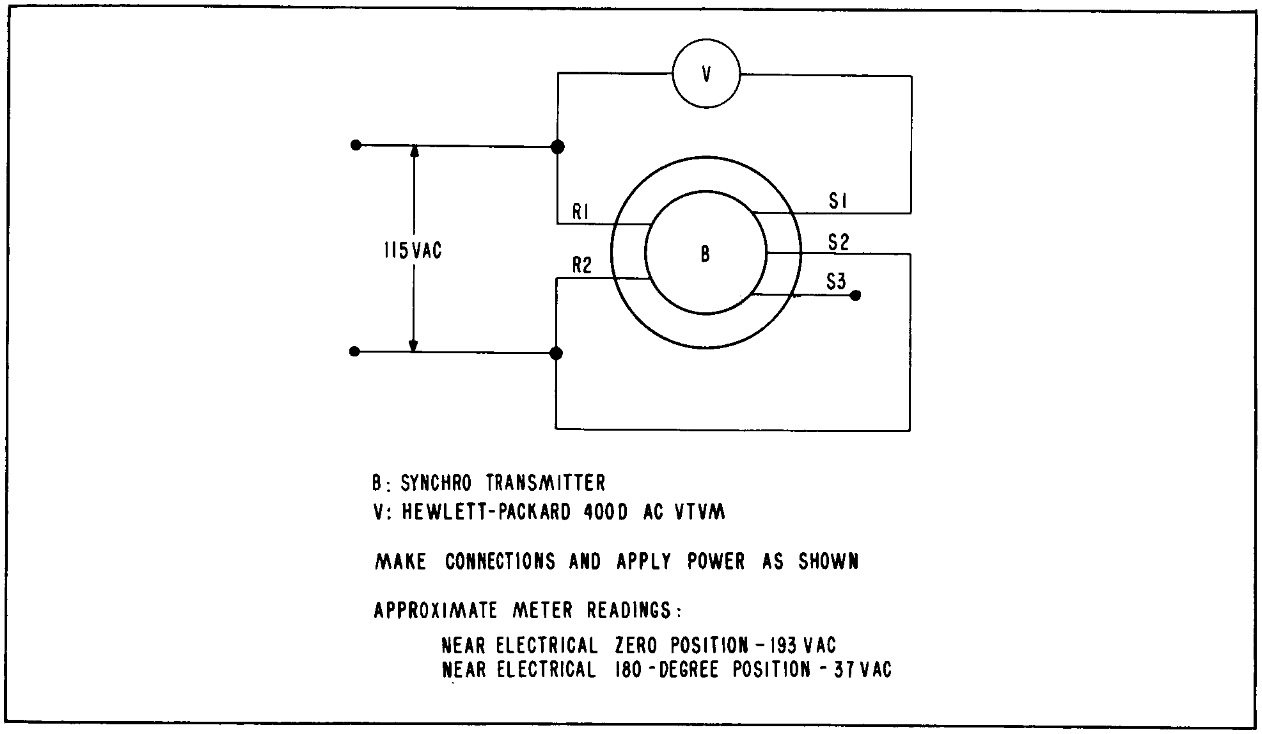


Figure 5-3. Method of Locating Approximate Position of Synchro Transmitter Electrical Zero

5. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.

a. If the meter reading is approximately 193 volts, the synchro is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 37 volts, the synchro is near electrical 180 degrees. Turn off the 115

VAC reference, loosen the screws which hold the case, and turn the case of the synchro halfway around, so that the meter reading is approximately 193 volts. Then proceed with the simplified zeroing procedure below.

c. If the meter reading is something roughly midway between 37 and 193 volts, the synchro is not near either zero or 180 degrees. Proceed with the simplified zeroing procedure to set the synchro near zero or 180 degrees. Then repeat the complete zeroing procedure.

(b). TRANSMITTER ZEROING PROCEDURE – SIMPLIFIED

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

Note

See paragraph 5-4. B. (2) for restrictions on the use of this procedure.

2. Turn off reference voltage (115 VAC) to the synchro.
3. Disconnect stator leads (S1, S2, S3) from the synchro.
4. Connect a voltmeter (Hewlett-Packard 400D) between synchro terminals S1 and S3. (See figure 5-4.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the zeroing procedure, set the meter to successively lower scales.
5. Loosen the screws which hold the case of the synchro so that the case is free to turn.
6. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.
7. Turn the case of the synchro in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the synchro back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt. This position is the electrical zero of the synchro.

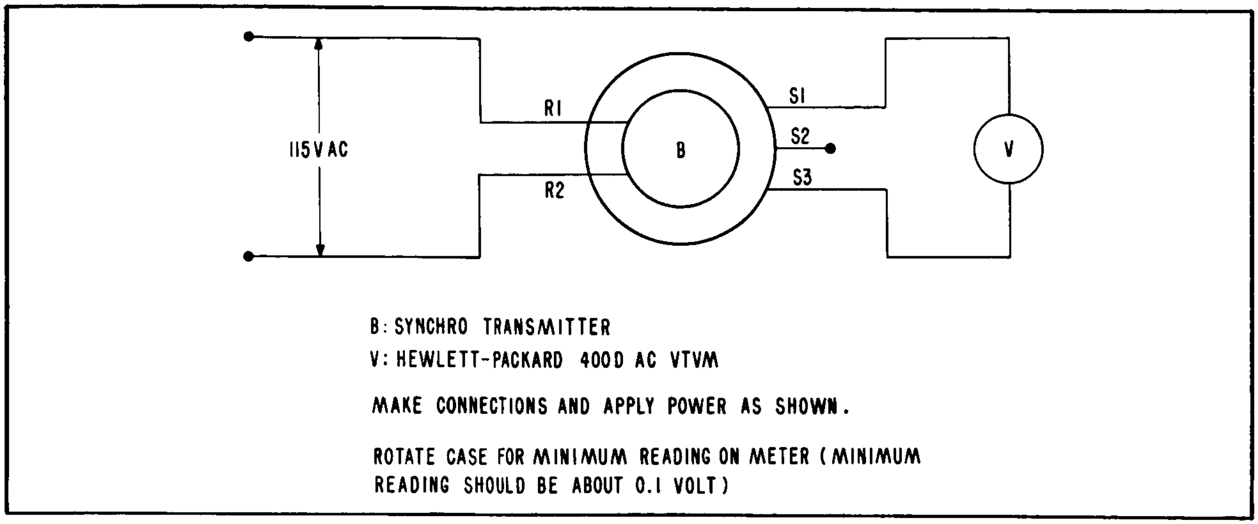


Figure 5-4. Method of Zeroing Synchro Transmitter

8. With the synchro set at electrical zero, tighten the screws which hold the case in place.
9. Turn off the reference voltage (115 VAC) and reconnect stator leads (S1, S2, S3).

(3). <u>SYNCHRO RECEIVERS</u>

This paragraph describes procedures for zeroing and for reversing synchro receivers. Two procedures for reversing receivers are described; one of these can be used for any synchro receiver, and the other, which is simpler, is limited in application to those receivers which have no internal or external jumpers between a rotor lead and a stator lead. Synchros with jumpers are hereafter called the four-wire type, and those with no jumpers are called the five-wire type. (All of the synchro receivers on the acquisition data console are the four-wire type. Terminals R2 and S2 are internally jumpered.)

(a). <u>RECEIVER ZEROING PROCEDURE</u>

This procedure is applicable to those synchro receivers which are not supplied from a synchro line amplifier. (A synchro line amplifier reverses the phase of the stator voltages; hence, synchro receivers connected to the output of an amplifier require reversing, not zeroing.)

1. Turn off reference voltage (115 VAC) to the synchro.

2. Disconnect stator leads (S1, S2, S3) from the synchro.

3. Connect a variac (General Radio Type W10MT) as shown in figure 5-5).

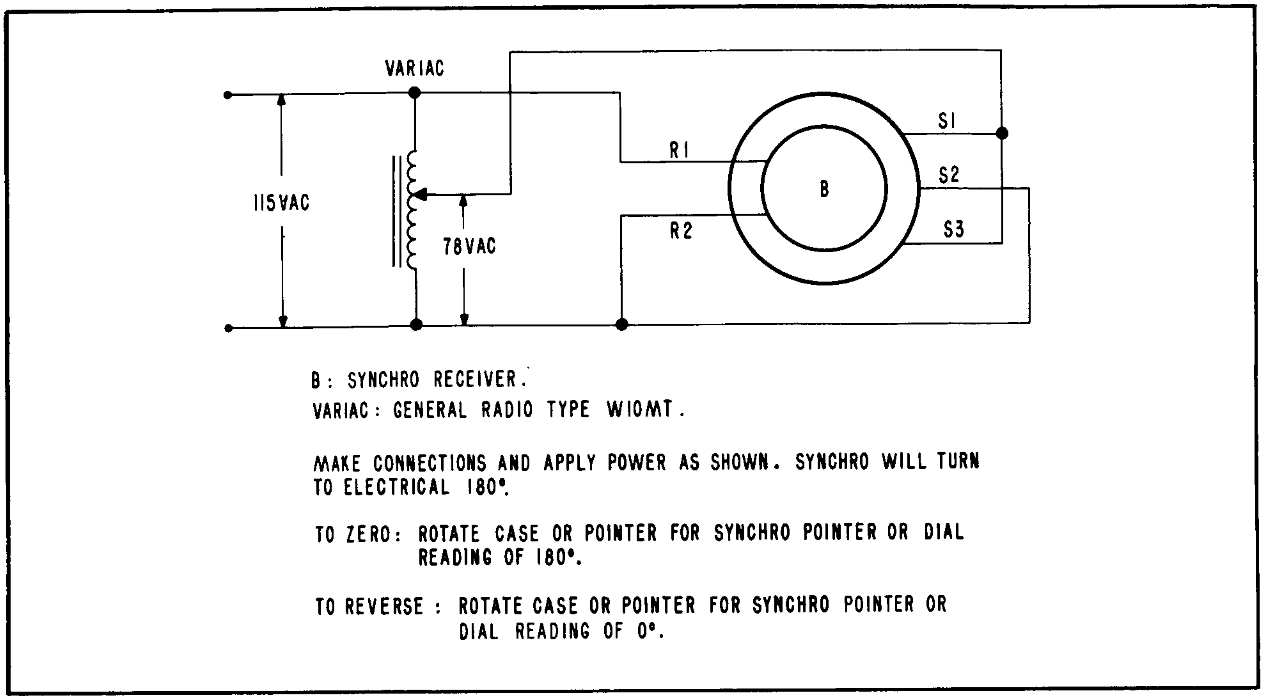


Figure 5-5. Method of Zeroing or Reversing Synchro Receiver

4. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

5. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at 180 degrees.

6. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now zeroed.

Note

The synchro receivers on the acquisition data consoles are so constructed that they cannot be zeroed by turning the case; the pointer must be turned on the rotor shaft. Partially disassemble the synchro and remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4. C.

(b). RECEIVER REVERSING PROCEDURES

The procedures which follow are applicable to synchro receivers which are connected to the output of a synchro line amplifier. Two procedures are described; the first is a very simple method of reversing (changing by 180 degrees) the reading of a receiver, but it cannot be used on synchros with four-wire connections (jumpers between rotor and stator leads) and it does not provide a check of the accuracy of the synchro's indication. The second procedure can be used with either four- or five-wire connection synchro receivers and provides check and adjustment of the receivers indication as it is actually a procedure for "zeroing" at 180 degrees.

1. R1-R2 INTERCHANGE

CAUTION

Do not apply this procedure to any of the synchros on the acquisition data console or any others which have jumpers, internal or external, between a rotor winding and a stator winding. To do so may result in a direct short circuit of the 115 VAC reference voltage.

a. Turn off the 115 VAC reference voltage.

b. Disconnect the external leads from the synchro R1 and R2 terminals.

c. Connect to R1 the external lead which was formerly on R2.

d. Connect to R2 the external lead which was formerly on R1. The synchro reading is now reversed (different by 180 degrees) from what it was before R1 and R2 were interchanged.

2. "ZEROING" AT 180 DEGREES

a. Turn off reference voltage (115 VAC) to the synchro.

b. Disconnect stator leads (S1, S2, S3) from the synchro.

c. Connect a variac (General Radio Type W10MT) as shown in figure 5-5.

d. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and the terminals S1-S3. The synchro will turn to electrical 180 degrees.

e. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at zero degrees.

f. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now reversed.

Note

For synchros on the acquisition data console, see the note under paragraph 5-4. B. (3). (a). regarding zeroing by turning the pointer on the rotor shaft. For reversing, or "zeroing" at 180 degrees, follow the procedure in the referenced note, except turn the pointer to zero degrees.

(4). CONTROL TRANSFORMERS

Two procedures, one complete and one simplified, for zeroing control transformers are given below. As was discussed for the case of synchro transmitters in paragraph 5-4. B. (2)., the simplified procedure should be used only when the approximate electrical zero position of the control transformer is known. Normally the approximate electrical zero position is known and the simplified procedure can in most cases be used.

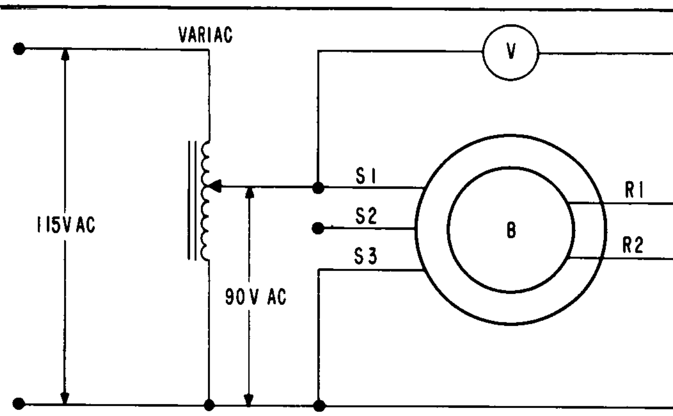
(a). CONTROL TRANSFORMER ZEROING PROCEDURE—COMPLETE

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals R2 and S3 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-6.)

4. Connect a variac (General Radio Type W10MT) between terminals S1 and S3 as shown on figure 5-6 and apply 90 VAC to these terminals.



B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER. (MINIMUM READING SHOULD BE ABOUT 30 VOLTS).

Figure 5-6. Method of Locating Approximate Position of Control Transformer Electrical Zero

a. If the meter reading is approximately 30 volts, the control transformer is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 120 volts, the control transformer is near electrical 180 degrees. Turn off the power, loosen the screws which hold the case, and turn the case of the control transformer halfway around. Turn the power back on; the meter reading now should be approximately 30 volts. Proceed with the simplified zeroing procedure.

(b). CONTROL TRANSFORMER ZEROING PROCEDURE — SIMPLIFIED

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

Note

See paragraph 5-4. B. (4). for restrictions on the use of this procedure.

2. Disconnect the rotor (R1, R2) and stator(S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals S1 and S3 and connect a voltmeter (Hewlett-Packard 400D) between terminals R1 and R2. (See figure 5-7.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the procedure, set the meter to successively lower scales.

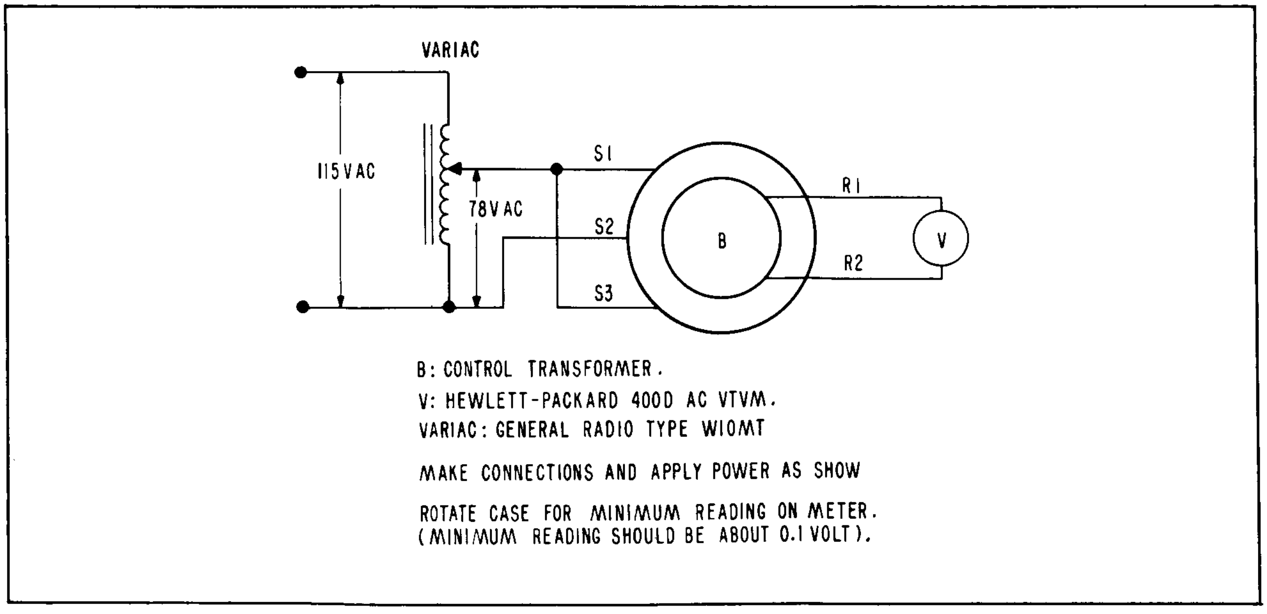


Figure 5-7. Method of Zeroing Control Transformer

4. Loosen the screws which hold the case of the control transformer so that the case is free to turn.
5. Connect a variac between terminals S1 and S2 as shown in figure 5-7 and apply 78 VAC to these terminals.
6. Turn the case of the control transformer in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the control transformer back and forth to locate the position of null voltage on the meter. Null voltage should be about 0.1 volt. This position is the electrical zero of the control transformer.
7. With the control transformer set at electrical zero, tighten the screws which hold the case in place.
8. Turn off power and reconnect the control transformer for normal operation in its circuit.

(5). SYSTEM ALIGNMENT

In a system consisting of a synchro transmitter and a synchro receiver or control transformer, there are three places where misalignment errors commonly arise. These three are the transmitter, the receiver, and the circuits which connect the transmitter to the receiver. When the connecting circuits consist simply of cabling and/or fixed transformers, no adjustments can be made to them; errors can be corrected only at the transmitter or receiver. When the connecting circuits include a synchro line amplifier, error-correcting adjustments can be made at the transmitter, the receiver, and at the amplifier. In a simple system consisting of a single transmitter, synchro line amplifier and receiver or control transformer (a control transformer for the purposes of this discussion being equivalent to a synchro receiver), a misalignment error can be corrected by adjusting any one of the three elements (transmitter, amplifier, or receiver). In such a simple system it is immaterial where the source of error actually is; a misadjustment of the transmitter can be compensated for by adjusting the receiver to introduce an equal and opposite error. The only criterion for proper operation is that when the device which drives the synchro transmitter is pointing at a given angle, the synchro receiver indicates that angle. However, the synchros in the acquisition system are not in a simple arrangement as described, and although shortcut methods can and should be used as the technician becomes familiar with the configuration and characteristics of the system, the general procedure given below should be followed in most cases:

(a). When an error is noted in the synchro system, determine if possible whether the error is due to a "trouble" or a misadjustment. The criteria for making this determination are discussed in paragraph 5-3.

(b). Isolate the source of the error as much as possible. That is, where there is more than one receiver connected to a transmitter, check all of the receivers to see whether the error shows up on all or on only one; switch between two transmitters which can be connected to a single receiver. (See figure 5-8. This illustration is a schematic of both the azimuth and elevation synchro systems, which are virtually identical.)

(c). Individually check the adjustment of each of the units (transmitter, receiver, control transformer, and synchro line amplifier) for possible source of the particular error. Careful adjustment of the individual units should correct the majority of system errors. Individual check and adjustment procedures for synchro transmitters and receivers and control transformers are given in paragraphs 5-4. B. (2), (3), and (4)., and procedures for the synchro line amplifier are given in paragraph 5-4. G.

(d). When all of the individual units involved have been properly adjusted and the error still persists, its source must be in the connecting cabling. An error arising in the cabling, so long as it is constant at all angular positions of the synchros, can be compensated for by introducing equal and opposite errors into the synchro receivers. Thus, when individual adjustment of the units of the system does not correct the error, system alignment should be made as follows:

1. Do not change the synchro transmitters or synchro line amplifiers; i.e., leave these units as they were set in accordance with the individual adjustment procedure.

2. Set the device mechanically coupled to the transmitter to a known position (azimuth or elevation).

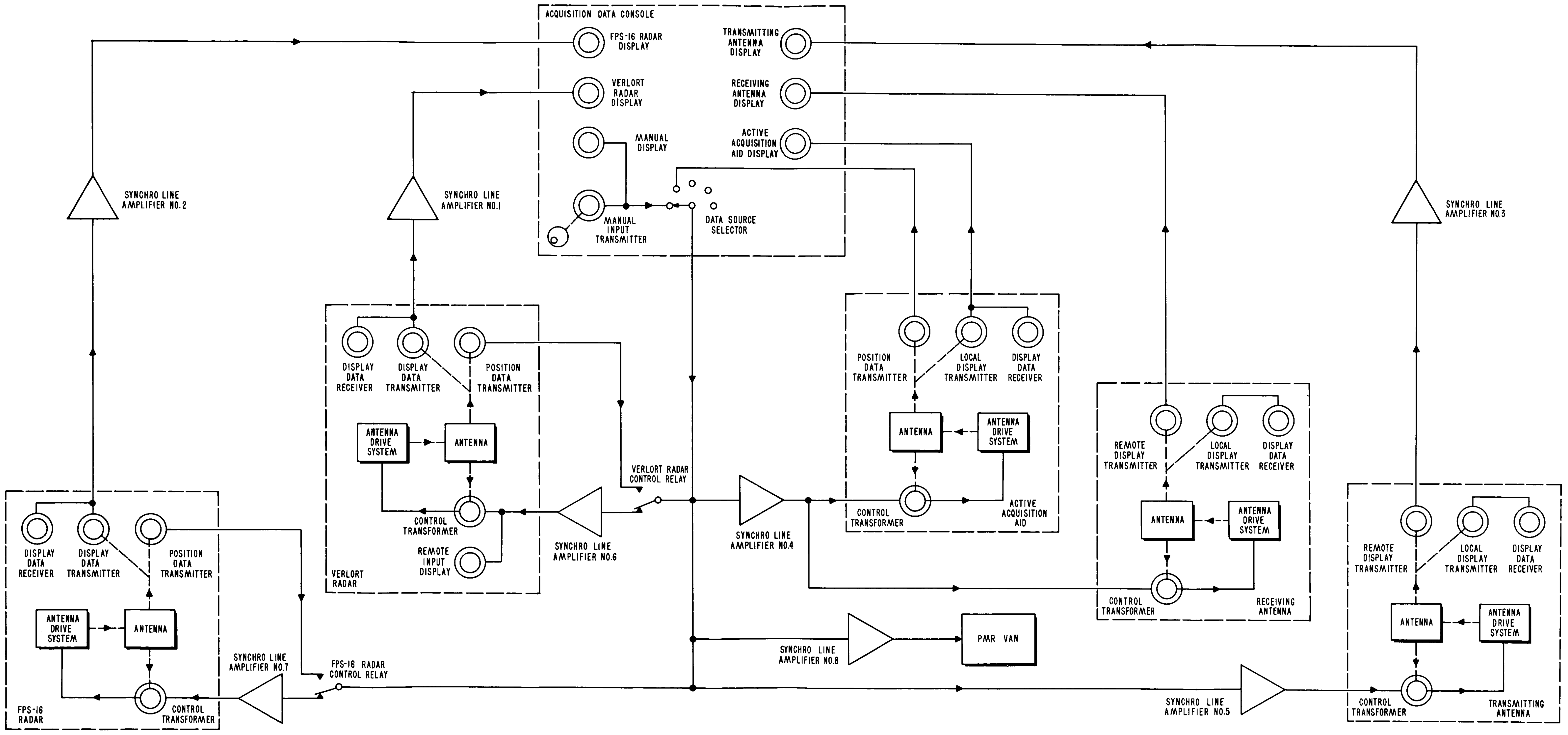


Figure 5-8. Azimuth and Elevation Synchro System, Schematic Diagram

other equipment, comparable d-c resistance measurements should be obtained. (When a resistance measurement is doubtful, compare the resistances of corresponding windings in two identical synchros, or two windings of the same synchro.)

(2). DISASSEMBLY

The disassembly procedure described in this paragraph applies to the synchro receivers on the acquisition data console. See figure 5-9.

(a). Dismount the synchro from the panel by removing the four mounting screws and nuts.

(b). Remove the eight screws which hold the bezel onto the front housing. Remove the bezel, dial plate and gasket and set them aside.

(c). Pull or pry the pointer off the end of the rotor shaft. As shipped from the factory the pointer is secured to the shaft with a drop of glue and considerable force may be necessary to remove it. However, care should be exercised not to damage the fragile pointer during removal.

(d). Pull out the retaining ring and remove the dial.

(e). Remove the four screws which hold the front and rear housings together. Remove the front housing and "0" ring. With the front housing removed, only the wires from the connector to the synchro itself hold the synchro in the rear housing. Do not hold the rear housing in such a position that the connecting wires support the weight of the synchro.

(f). Remove the four screws which fasten the connector to the rear housing.

(g). Pull the connector as far away from the rear housing as the wiring permits and unsolder the wires from the connector pins. Remove the synchro itself from the rear housing. This is as far as field disassembly should proceed.

(3). ASSEMBLY

Assembly of the synchro receivers on the acquisition data consoles is the reverse of the disassembly procedure, except that particular attention should be

3. For synchro receivers, loosen the screws which hold the case and with the synchros energized (115 VAC applied) turn the case so that the receiver indication is the same as the position of the antenna.

Note

The case of the synchro receivers on the acquisition data console cannot be turned; the pointer must be turned on the rotor shaft. Refer to the note in paragraph 5-4. B. (3). (a).

4. Before adjusting a control transformer to compensate for errors introduced by interconnecting cabling, be sure that changing the setting of the control transformer will not introduce an error into the positioning system with which the control transformer is associated.

C. SYNCHRO REPAIR

(1). REPAIR PROCEDURES

(a). It is recommended that major repairs on synchro devices (transmitters, receivers, and control transformers) not be attempted in the field. However, minor repairs such as replacing broken pointers or dial plates and repairing broken connections (where wiring is accessible) can be made. For information on replacement of defective parts or gaining access to internal wiring of synchros on the acquisition data console, refer to the disassembly and assembly procedures below. For information on other synchros in the acquisition system, refer to the applicable equipment manuals.

(b). When there is a question as to whether a synchro is defective and requires replacement, the winding resistances should be checked. For the synchros on the acquisition data console the d-c resistance of the stator windings (S1-S2, S2-S3, and S1-S3) should be about 95 ohms at room temperature, and the d-c resistance of the rotor winding (R1-R2) should be about 85 ohms at room temperature. For synchros in

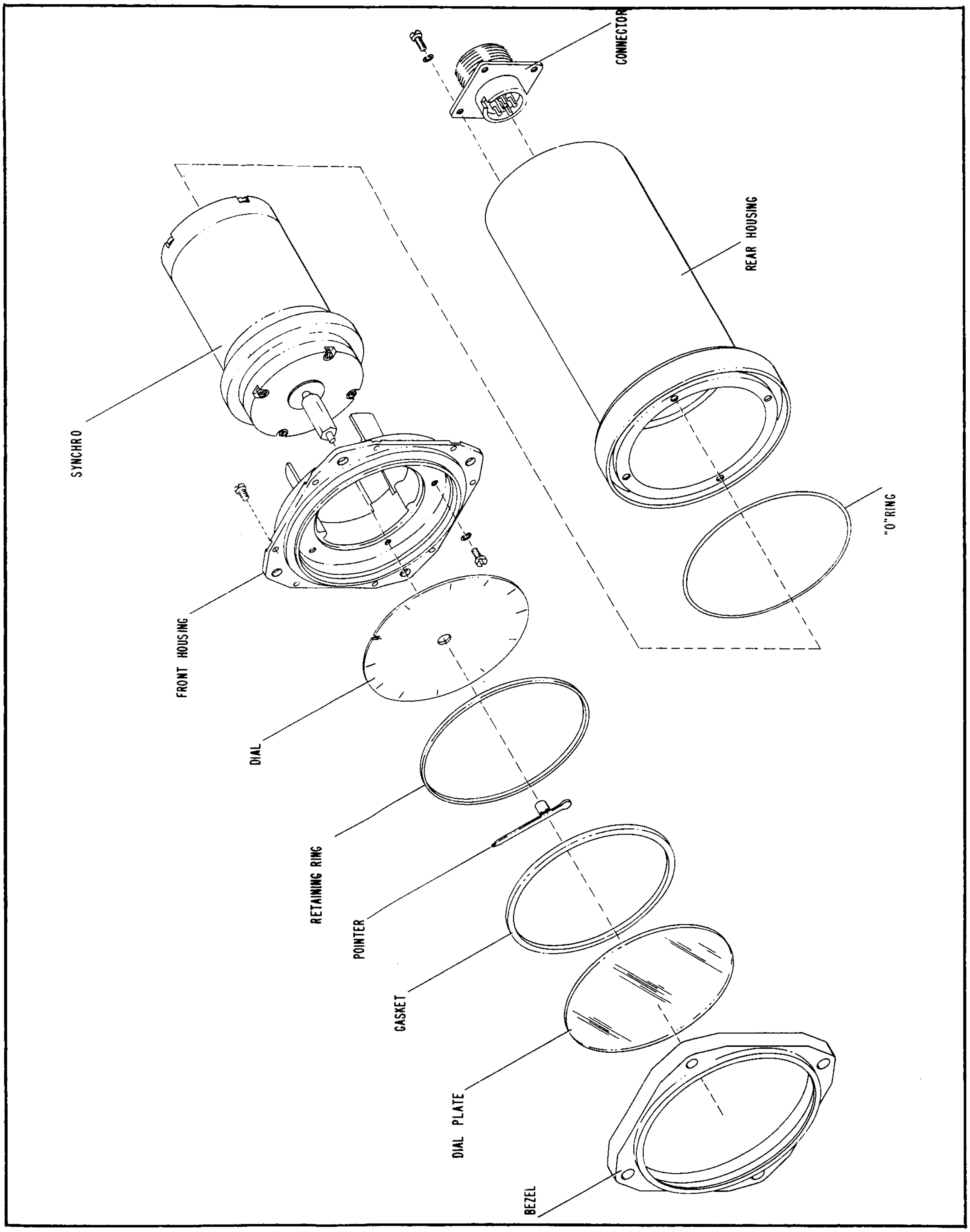


Figure 5-9. Acquisition Data Console Synchro Receiver, Exploded View

paid to the pointer. Be sure that the pointer is replaced at the proper angle on the rotor shaft (refer to paragraph 5-4. B. (3).) and, if necessary, crimp the pointer socket slightly to obtain a secure fit on the rotor shaft.

D. 28 VDC POWER SUPPLY

The acquisition data console 28 VDC power supply comprises two principal parts; one is the control circuits and the other is the dual power supply. The control circuits consist of relays and diodes, on a relay chassis, and the switch assemblies (with indicators), on acquisition data panel number 1. The dual power supply consists of a front panel (with a switch, fuses, and a power-on indicating lamp) and power supplies number 1 and 2, each consisting of a power supply unit and a filter unit. This paragraph describes adjustment and repair procedures for the control circuits and for the dual power supply. Since it is unlikely that a single trouble in the console will affect both power supplies number 1 and number 2 and their associated control circuits, the repair procedures are based on the assumption that only one power supply and/or its associated control circuits is malfunctioning. If neither power supply is operative, check switch S6201 on the dual power supply and check the primary power, 115 VAC, to the console.

(1). CONTROL CIRCUITS

The following procedure is applicable specifically for checking and isolating trouble in the control circuits associated with power supply number 1. With appropriate substitutions in the reference designations of components, terminals, etc., the same procedure is applicable to the control circuits associated with power supply number 2.

(a). With switch S6201 on the dual power supply in the off position, connect a temporary jumper around blocking diode CR6001. The purpose of the jumper is to connect 28 VDC from power supply number 2 to the control circuits of power supply number 1.

(b). Remove plug P6201 from jack J6201 on the dual power supply.

(c). Turn on switch S6201 on the dual power supply and depress switch S6007 on the acquisition data panel. Power supply number 2 is energized and 28 VDC is applied to the control circuits of power supply number 1. If the power supply number 1 control circuits are functioning properly, the green indicator lamps in switch S6006 on the acquisition data panel will be lit, and the switch when depressed will stay depressed, connecting 115 VAC to pins A and B of plug P6201 (measure with a voltmeter). Failure to perform as described indicates that the trouble is in the control circuits; proceed as follows to isolate the trouble.

(d). With a voltmeter measure the voltage across zener diode CR6003. It should be 18±1 VDC; if it is not, the diode is defective.

(e). Check the coil and contacts of relay K6001. The coil should have a d-c resistance of 1000 ohms. The contacts can conveniently be checked by measuring the voltage drop across each pair that should be closed; there should, of course, be no voltage across closed contacts.

(f). Check the coil, contacts, and indicator lamps in switch S6006. The coil should have a d-c resistance of 480 ohms. Check the contacts for voltage drop across each pair that should be closed.

(2). <u>DUAL POWER SUPPLY</u>

(a). <u>ADJUSTMENT</u>

The individual power supplies in the dual power supply should be adjusted so that at the maximum normal load imposed by the console and with the prevailing a-c line voltage input to the console, the output of each power supply onto the console 28 VDC bus is as close as possible to 25 VDC. With a given a-c line voltage, a d-c output voltage within the range of 24 to 26 VDC normally should be obtainable. If only the extremes of this range can be obtained, the output voltage should be set at the higher end of the range. Also, the power supplies should be adjusted so that with extremes of line voltage fluctuation and with d-c load variations from minimum to maximum, the d-c voltage output of the dual power supply is in no case greater than 30 VDC or less than 22.5 VDC. Voltages greater than 30 VDC are likely to overheat and thus damage the color filters in the console indicators, any voltage less than 22.5 VDC may not be sufficient to operate the power supply control circuits. The curves of figures 5-10 and 5-11 are provided for reference in case it is necessary to adjust the power

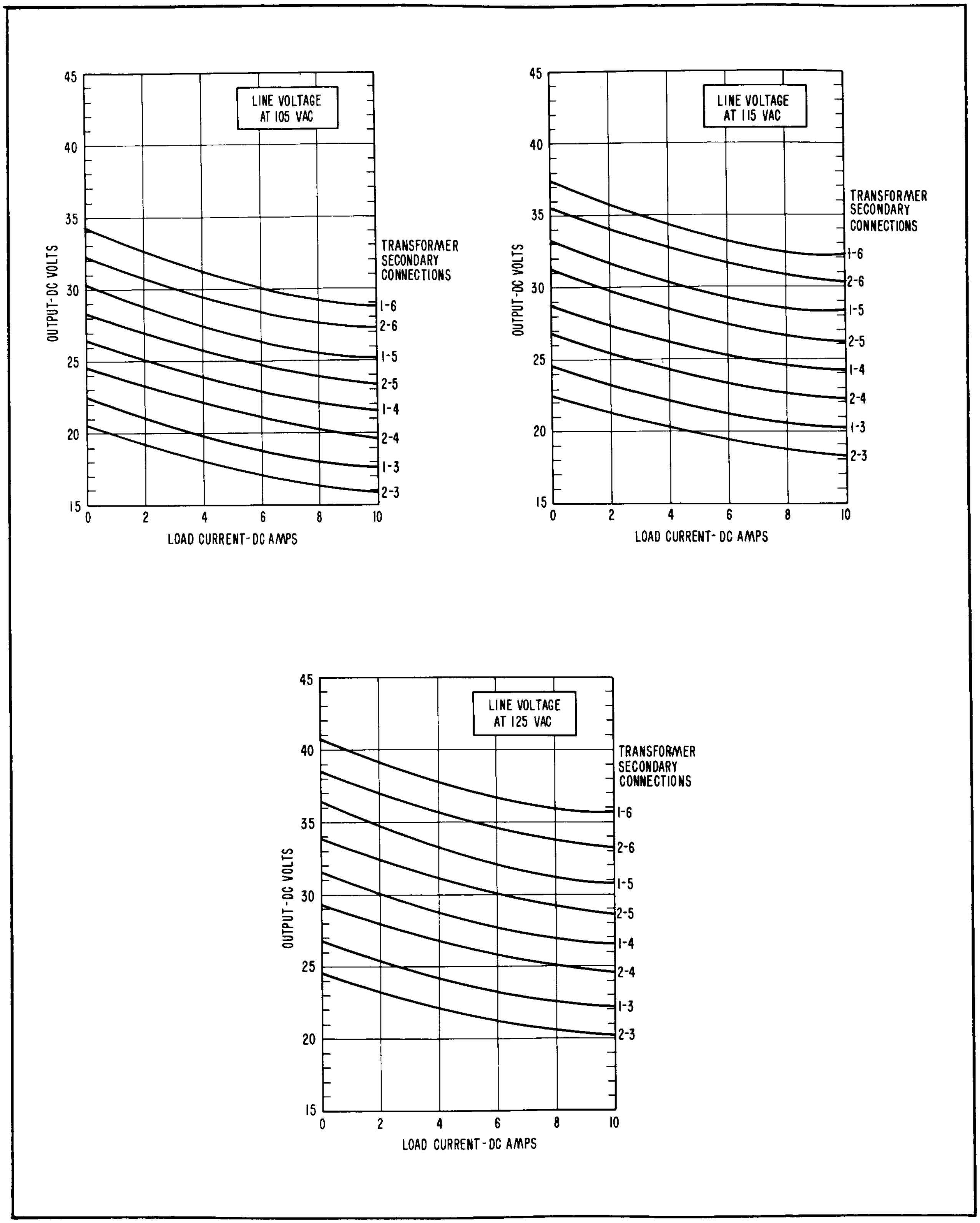


Figure 5-10. Power Supply and Control Circuit Output Voltage versus Load Current Characteristics

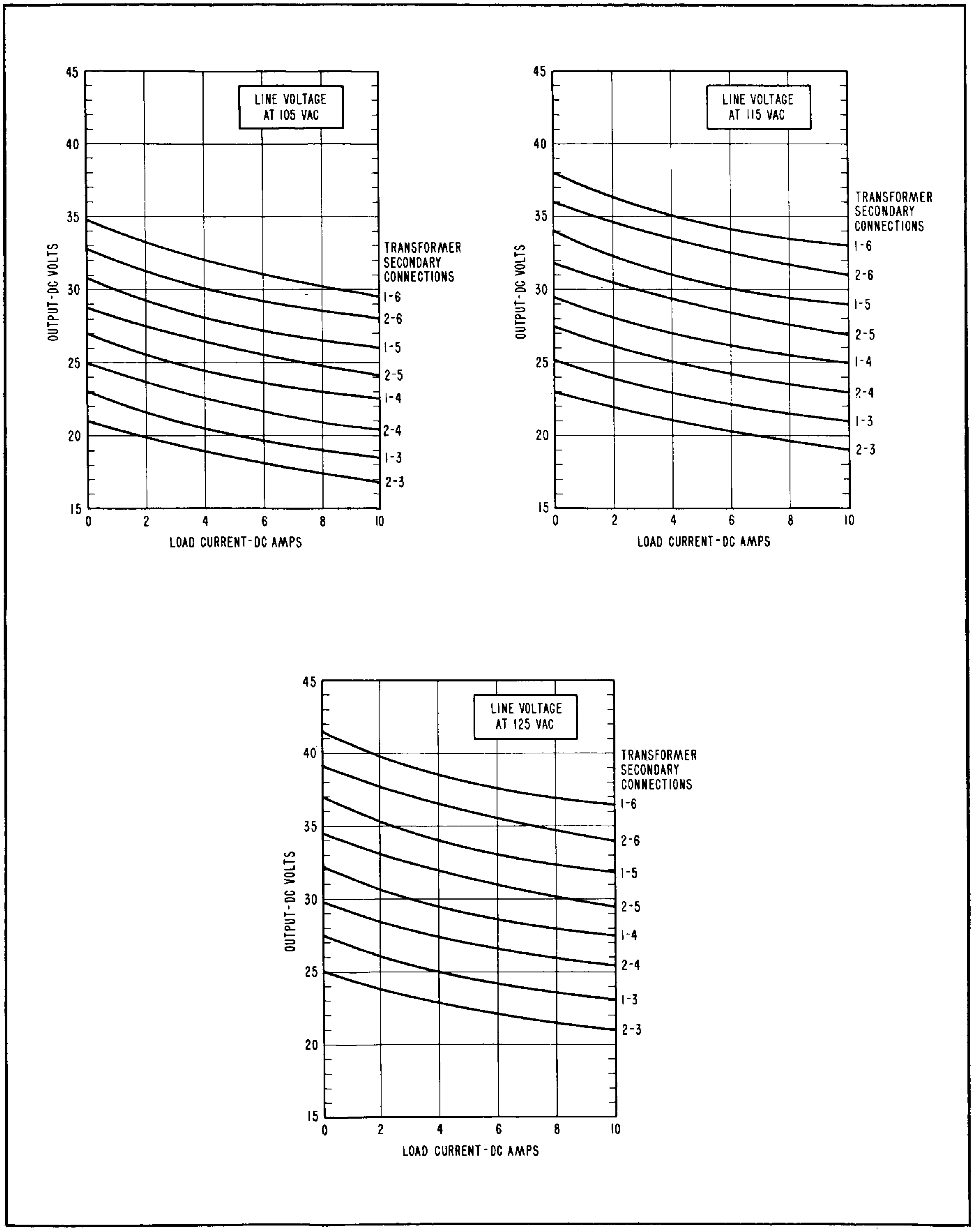


Figure 5-11. Power Supply Output Voltage versus Load Current Characteristics with Control Circuit Disconnected

supplies with an a-c line voltage other than the prevailing one or with loads which differ appreciably from the normal maximum. The curves of figure 5-10 include the effects of the power supply control circuits and therefore apply when the dual power supply is in the console and voltages are measured on the console 28 VDC bus. The curves of figure 5-11 apply when the control circuits are disconnected and voltages are measured right at the output of a filter unit (terminal board TB6203 or TB6204, terminals 3 and 2), as when the dual power supply is on the bench. For an a-c line voltage near 115 VAC, transformer secondary connections to terminal board terminals 2 and 4 should provide the proper d-c output voltage. (The maximum normal load is approximately one ampere.) For other a-c line voltages, the curves of figures 5-10 and 5-11 show the transformer secondary connections which should produce the correct output voltage. Proceed as follows to check and adjust the power supply output voltages when the dual power supply is connected to the console for normal operation. The procedure for checking and adjusting when the dual power supply is on the bench is essentially the same as the following, but the details of the on-the-bench procedure will depend on the particular test setup used:

1. Energize power supply number 1 by turning on switch S6201 on the dual power supply and depressing "28V SUPPLY" switch S6006.

2. Apply maximum normal load to the power supply by energizing as many switches, indicators, and relays as can be energized at one time.

3. Measure the voltage output of power supply number 1 on terminal board TB6001 or any other convenient place on the console 28 VDC bus. (See figure 7-1.)

4. The output voltage of the power supply should be as described above (24 to 26 volts with the prevailing a-c line voltage supplied to the console). If it is not, adjust the voltage by changing on terminal board TB6201 the connections to the secondary taps of

transformer T6201. By changing these connections, the d-c output voltage of the power supply can be adjusted over a range of about 14 volts in steps of approximately two volts. Moving one connecting wire between TB6201 terminals 3 and 4, 4 and 5, or 5 and 6 increases or decreases the d-c output by about four volts; and moving the other connecting wire between TB6201 terminals 1 and 2 increases or decreases the output voltage by about two volts. (See figure 5-12.)

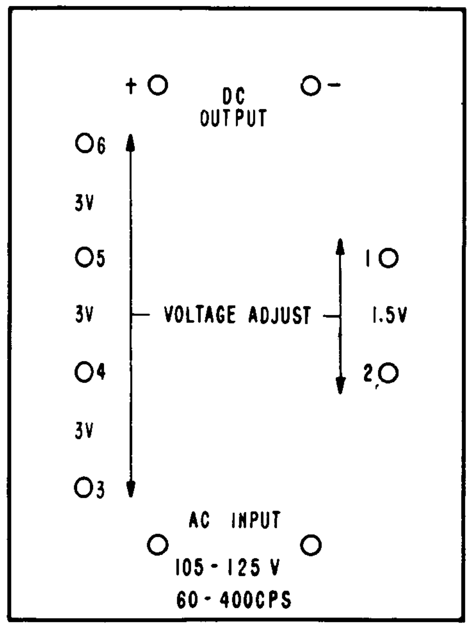


Figure 5-12. Power Supply Unit Terminal Board

5. Turn off power supply number 1 and repeat steps on through four with appropriate changes in reference designations for power supply number 2.

(b). REPAIR

Correction of a malfunction in the dual power supply can be affected by conventional trouble shooting and repair procedures. Check a-c and d-c voltages, and check continuity of power transformer T6201 or T6202 and filter choke L6201 or L6202. See the dual power supply schematic and physical wiring diagrams, figures 7-3 and 7-4. For the location of parts on the power supply units and filter units, see figure

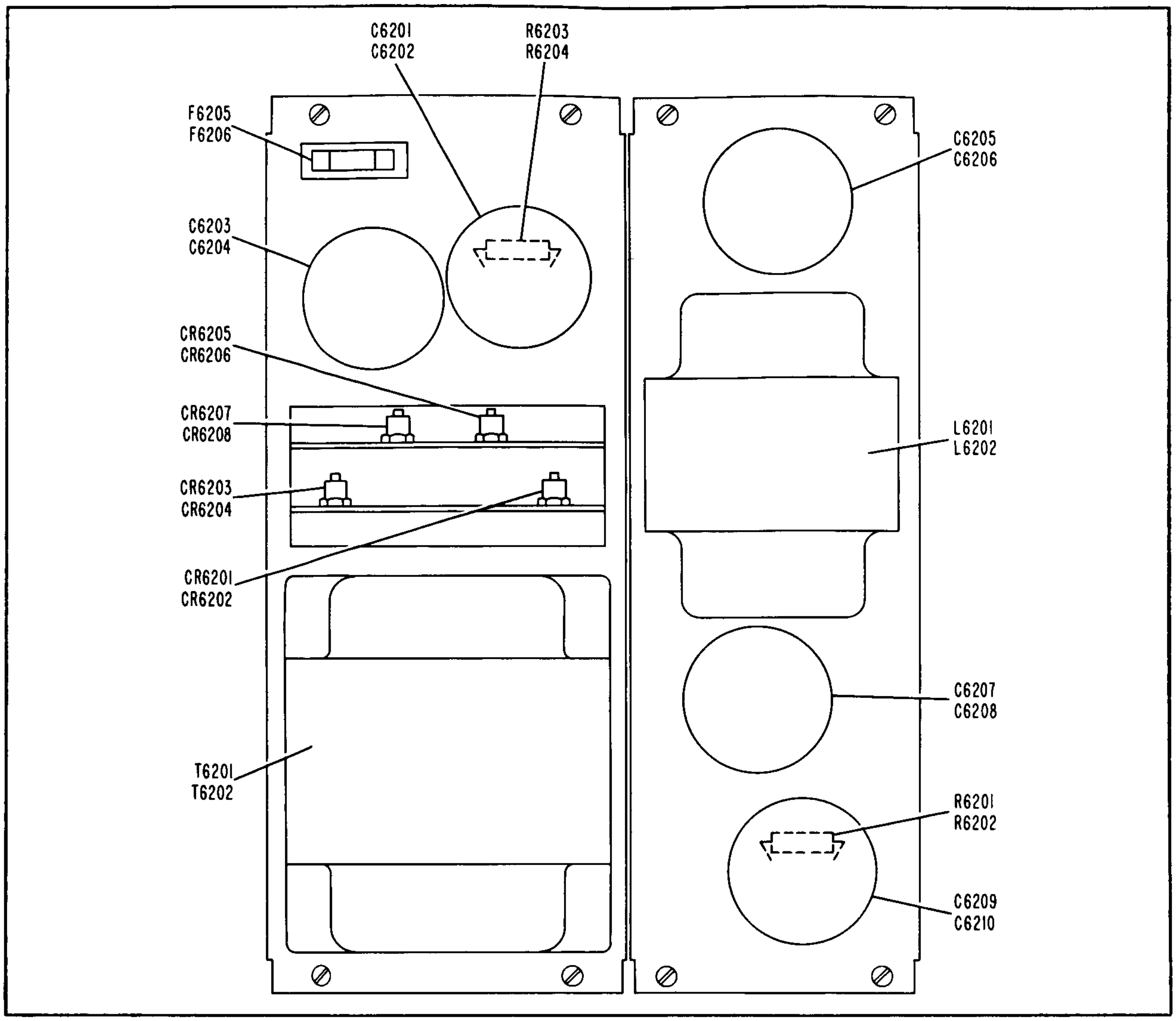


Figure 5-13. Power Supply Unit and Filter Unit, Parts Location

5-13. Normal a-c voltages for the power transformers are shown in table 5-II. Bear in mind that two switches are in series with the primary 115 VAC power to each power supply in the dual power supply; for power supply number 1 these switches are S6201 on the dual power supply and S6006 on the acquisition data panel. For power supply number 2 the switches are S6201 on the dual power supply and S6007 on the acquisition data panel. Bear in mind also that in addition to the fuses (F2601-F6204) on the front of the dual power supply, there is another fuse (F6205, F6206) on each of the power supply units (PS6201 and PS6202).

TABLE 5-II. NORMAL POWER TRANSFORMER VOLTAGES (T6201, T6202)

Terminal (TB6201 or TB6202)	Approximate RMS Voltage
1-6	28
2-3	18
1-2	1.5
3-4	3
4-5	3
5-6	3
7-8	115

E. RELAYS

(1). All of the relays used on the acquisition data console are hermetically sealed, and no maintenance or repair is possible. When one of them becomes defective, replace it. To ascertain that a console relay is defective, check the following:

(a). Coil resistance: D-c coil resistances should be as follows:

1. K6001, K6002: 1000 ohms.
2. K6003, K6004: 200 ohms.
3. K6010, K6011: 10.5K ohms.

Note

Diodes are in series with the coils of relays K6010 and K6011. Hence polarity must be observed when measuring the resistance of these coils with an ohmmeter. (See figure 7-1.) The resistance given is that of the coil plus diode forward resistance.

(b). Contacts: With all power off, check continuity between normally-closed contacts. With the suspected relay energized and voltage applied across the contacts, check for voltage drop across normally-open contacts. There should, of course, be none.

(2). For detailed information on relays in the acquisition system outside the acquisition data console, see the applicable equipment manuals.

F. SWITCH AND INDICATOR ASSEMBLIES

For a description of acquisition data console switch and indicator assemblies and how they work, refer to paragraph 4-2. B. (3) and figure 4-5.

(1). INDICATORS AND OPERATOR-INDICATOR UNITS

Maintenance of indicators and the operator-indicator unit portion of switch assemblies consists simply of replacing loose or defective lamps and color filters. Replacement of these items is most easily accomplished with the use of the special lamp-filter tool shown in figure 5-15 (Microswitch part number 15PA19).

(2). COILS

The coil portion of switch assemblies can best be checked by observing the action of the plunger. When the plunger is depressed and the coil energized, the plunger should remain securely in the depressed, or actuated, position. Also check the d-c resistance of the coil. It should be about 480 ohms.

(3). SWITCHES

The operation of the switch portion of switch assemblies can be checked by seeing whether all of its contacts make and break properly as the coil plunger is depressed and released. Faulty or intermittently faulty operation of a switch section can often be corrected by adjusting the amount of bend in the small arm which actuates the individual switch section plunger (as distinguished from the main, or coil plunger.) When the operation of a switch section is faulty and cannot be corrected, the entire switch portion of the switch assembly must be replaced.

G. SYNCHRO LINE AMPLIFIER

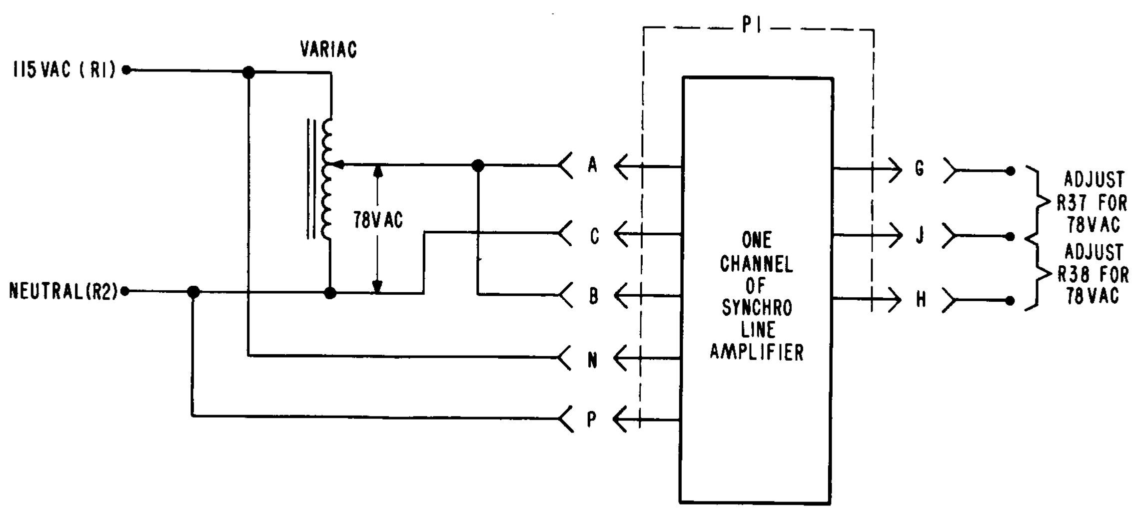
This paragraph covers two procedures for adjusting the synchro line amplifiers; one is an on-the-bench procedure whereby the amplifier can be adjusted independently of any synchros and the other is an in-system procedure, which in some cases will be more convenient to perform or may be necessary for touching up the adjustments. However, of the two, the on-the-bench procedure usually will produce the more satisfactory results; it is, therefore, the one which normally should be used. Both procedures described apply to both the azimuth and elevation channels of the synchro line amplifier (the two channels are identical). Thus, for complete adjustment of the amplifier, the procedure used will have to be followed twice, once of the azimuth channel and once for the elevation channel. For synchro line amplifier trouble shooting and repair procedures, see the applicable equipment manual.

(1). BENCH ADJUSTMENT

(a). Connect a variac (General Radio Type W10MT) to the synchro line amplifier channel which is to be adjusted. Connect the variac so that 78 VAC can be applied to the amplifier between pins C and A-B of jack P1. (See figure 5-14.)

WARNING

Be sure to connect the neutral (synchro R2 winding) side of the 115 VAC power to pin C of jack P1 on the line amplifier. Connecting the "hot" (synchro R1 winding) side of the 115 VAC power to pin C of P1 would put 115 VAC directly on the chassis of the synchro line amplifier.



VARIAC: GENERAL RADIO TYPE W10MT
V: HEWLETT-PACKARD 400D AC VTVM OR 410B VTVM

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.
ADJUST R37 (FRONT PANEL) FOR EXACTLY 78VAC BETWEEN P1-G AND P1-J.
ADJUST R38 (FRONT PANEL) FOR EXACTLY 78VAC BETWEEN P1-H AND P1-J.

Figure 5-14. Synchro Line Amplifier, Bench Adjustment Setup (b). Before the synchro line amplifier is turned on (by means of switch S1 on the front panel), adjust the output of the variac for 78 VAC.

(c). Turn on switch S1 of the amplifier channel to be adjusted and allow about 10 minutes warm-up time before proceeding with the adjustment procedure.

(d). With a voltmeter(Hewlett-Packard 400D AC VTVM or 410B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(e). Adjust calibration potentiometer R37 (on the front panel of the line amplifier, figure 3-4) for exactly 78 VAC on the voltmeter.

(f). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier, figure 3-4) for exactly 78 VAC between these pins.

(g). In order to balance the amplifier output precisely, reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 and R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Although there is little potential difference between pins G and H of P1, both of these pins are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

(2). IN-SYSTEM ADJUSTMENT

In-system adjustment of the synchro line amplifier consists of connecting a synchro transmitter to the input of the amplifier and adjusting the amplifier so that its output is the same as the output of the synchro transmitter. Any synchro transmitter which is normally connected to the synchro line amplifier can be used as the reference for adjustment, and in some cases the best system performance may be obtained if the adjustment is made with a normal load on the amplifier; i.e., with normal, operating connections made to the amplifier output. If difficulty is encountered in obtaining proper system alignment, the amplifier should be adjusted with normal load on the output and with no load on the output to see which method gives the better results.

(a). Apply power by means of switch S1 to the synchro line amplifier channel to be adjusted and energize the synchros connected to the line amplifier. Allow the amplifier to warm up for about 10 minutes.

(b). Set the synchro transmitter which is connected to the input of the amplifier to exactly zero degrees.

Note

When using this procedure, the accuracy of the synchro line amplifier adjustment is dependent on the accuracy of the synchro transmitter used. Therefore, be sure that the synchro transmitter has been properly adjusted. (Refer to paragraph 5-4.B.)

(c). With a voltmeter (Hewlett-Packard 400D AC VTVM or 410B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(d). Adjust calibration potentiometer R37 (on the front panel of the line amplifier) for exactly 78 VAC on the voltmeter.

(e). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier) for exactly 78 VAC between these pins.

(f). Reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 or R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Pins G and H of P1 are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

H. SIGNAL STRENGTH METER CALIBRATION

To calibrate each of the signal strength meters on the active acquisition signal strength meter panel, proceed as follows:

(1). Connect an r-f signal generator to the telemetry receiver with which the meter to be calibrated is associated. (Refer to the Telemetering System Manual, MS-106, for further information on the signal generator and telemetry receiver.)

(2). With the telemetry receiver in operating condition and the signal generator frequency set at the operating frequency of the receiver, adjust the signal generator output level at 100 microvolts.

(3). Adjust SIGNAL STRENGTH METER CALIBRATION CONTROL R1, R2, R3 or R4 (figure 3-6) until the meter with which it is associated indicates 100 microvolts.

5-5. LUBRICATION

Table 5-III is a lubrication schedule for all of the equipment in the acquisition system.

5-6. SPECIAL TOOLS

The only special tool required for maintenance of the acquisition system is the lamp-filter tool (Microswitch part number 15PA19, Bendix Radio Part number A683836-1). This tool, shown in figure 5-15, is used for removal and replacement of the lamps and color filters in the indicators and switch assemblies on the acquisition data console.

5-7. TEST EQUIPMENT

Each piece of test equipment required for maintenance of the acquisition system is listed in table 5-IV along with a brief description of its application.

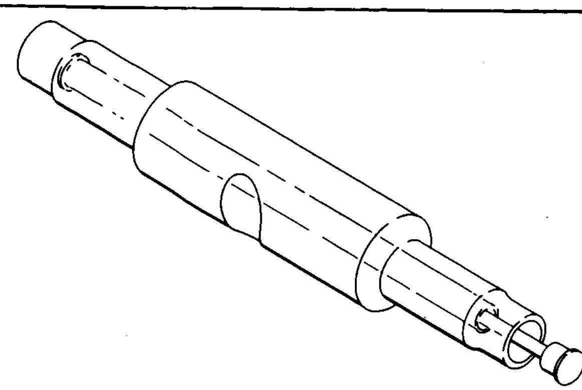


Figure 5-15. Lamp-Filter Tool

TABLE 5-III. LUBRICATION SCHEDULE

Lubrication Point	Procedure	Lubricant	Frequency
ACQUISITION DATA CONSOLE			
No lubrication required.	-	-	-
SYNCHRO LINE AMPLIFIERS			
No lubrication required.	-	-	-
ACTIVE ACQUISITION AID			
Elevation Drive Assembly.	Add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Monthly
Azimuth Drive Assembly.	Drain water from sump and add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Weekly
Antenna Control Unit.	Clean and re-lubricate gears. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil and lubriplate.	As required
Muffin Fans in RF Housing.	Lubricate with one or two drops of oil. Refer to equipment manual.	Aero Shell No. 12 (MIL-L-6085)	Monthly

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS

Equipment	Manufacturer	Model	Application
Oscilloscope	Hewlett-Packard Company	130B	General waveform observation and voltage measurements.
Oscilloscope	Tektronix, Incorporated	545A	General waveform observation and voltage measurements.
Wide-Band, High-Gain Calibrated Preamp	Tektronix, Incorporated	Type B	Oscilloscope plug-in unit used with Tektronix 545A.
Dual-Trace Calibrated Preamp	Tektronix, Incorporated	Type CA	Oscilloscope plug-in unit used with Tektronix 545A.
Plug-In Preamplifier	Tektronix, Incorporated	Type L	Oscilloscope plug-in unit used with Tektronix 545A.
Viewing Hood	Tektronix, Incorporated	H510	Aid in viewing of oscilloscope screens.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-2)	Support and transportation of oscilloscopes.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-1)	Support and transportation of oscilloscopes and storage of plug-in units.
Unit Regulated Power Supply	General Radio Company	1201-B	General bench testing of assemblies. Provides a source of a-c heater voltage at 6.3 VAC and 4A, and d-c plate power at 300 VDC and 70 MA.
Regulated Power Supply	Lambda Electronics Corporation	71	General purpose power supply with following outputs: 0-500 VDC, 0-200 MA; 0-200 VDC, 0-50 VDC, Bias; and 6.5 VAC, 5A.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	High resolution power supply with output of 0 to 555 volts and 0 to 300 MA for calibration purposes.
Square Wave Generator	Tektronix, Incorporated	Type 105	Alignment and testing of oscilloscopes and associated plug-in units.
Signal Generator	Boonton Radio Corporation	225-A	Test and alignment of receivers, sensitivity and bandwidth measurements in the 10- to 500- MC frequency range.
Sweep Generator	Telonic Industries, Incorporated	HN-3	Testing and adjusting r-f circuits in the frequency range of 0.5 to 300 MC.
HF Signal Generator	Hewlett-Packard Company	606-A	General purpose signal generator with a frequency range of 50 KC to 65 MC.
Function Generator	Hewlett-Packard Company	202-A	Test and adjustment of circuits which handle non-sinusoidal waveshapes.
Transfer Oscillator	Hewlett-Packard Company	540-B	Test and alignment of signal generators up to 2000 MC.
Wide Range Oscillator	Hewlett-Packard Company	200 CD	Test and adjustment of circuits in the range of 5 CPS to 600 KC.
Unit Oscillator	General Radio Company	1209-BL	Test and alignment of receivers, sensitivity and bandwidth measurements in the 180- to 600-MC range.
Universal EPUT and Timer	Beckman Instruments, Inc.	7370	Precision frequency measurements from 10 CPS to 11.5 MC.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Frequency Converter	Beckman Instruments, Inc.	7570 through 7573	Used with Beckman EPUT and timer to measure frequencies up to 220 MC.
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No. A683917)	Noise figure measurements in the 150-KC to 1000-MC frequency range.
Power Output Meter	The Daven Company	OP-962	Audio frequency power measurements in the power range of 0.1 milliwatt to 100 watts.
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	Precision d-c measurements with .05 per cent accuracy over the range of .01 to 500 volts.
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	General a-c, d-c, and r-f voltage measurements and resistance measurements.
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	Accurate a-c voltage measurements from .001 volt to 300 volts over a frequency range of 10 CPS to 4 MC
Volt-Ohm-Milliammeter	Triplett-Electrical Instrument Company	630-PL	General voltage, current and resistance measurement, (20,000 ohm/volt).
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	Measure total distortion of any frequency from 20 to 20,000 CPS.
RF Detector	Telonic Industries, Incorporated	XD-3	Detect output of r-f preamplifiers and i-f amplifiers in the 0.5- to 1000-MC range.
Tube Analyzer	Triplett Electrical Instrument Company	3444	Tube checks.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Variac	General Radio Company	W10MT	General purpose voltage source with output of 0-115 VAC at 10 amps.
Attenuator Pad	Telonic Industries, Inc.	TGC-50	Matching, isolation, and general bench test applications in the 0.5- to 1000-MC frequency range.
Miscellaneous Cables and Accessories	-	-	-

SECTION VI
PARTS LIST

6-1. GENERAL

This section comprises lists of the parts which make up the acquisition data console and the active acquisition aid control console signal strength meter panel. The lists are as follows:

Equipment	Parts List Table	Parts Location Illustration
Acquisition Data Console P/N R651465-2	6-I	Figure 7-2
Dual Power Supply, P/N R651470-2	6-II	Figures 5-13, 7-4
Intercom Panel, P/N N654990-5	6-III	—
Active Acquisition Aid Control Console Signal Strength Meter Panel, P/N L654992-1	6-IV	Figure 7-6
Miscellaneous Items	6-V	—

6-2. OTHER EQUIPMENT

For information on other equipment in the acquisition system, refer to the applicable equipment manuals, listed in table 1-II.

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N 651465-2

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
B6001	Synchro Display	N681819-3	-	1
B6002	Synchro Display	N681819-2	-	1
B6003	Synchro Display	N681819-3	-	1
B6004	Synchro Display	N681819-2	-	1
B6005	Synchro Display	N681819-3	-	1
B6006	Synchro Display	N681819-2	-	1
B6007	Synchro Display	N681819-3	-	1
B6008	Synchro Display	N681819-2	-	1
B6009	Synchro Display	N681819-3	-	1
B6010	Synchro Display	N681819-2	-	1
B6013	Synchro Display	N681819-3	-	1
B6014	Synchro Display	N681819-2	-	1
-	Synchro Transmitter Assembly, consisting of:	N654986-1	-	2
B6015, B6016	Synchro Transmitter	N683953-1	-	1
-	Spring, Compression	A689693-1	-	1
-	Bushing, Polyamide	A689682-1	-	1
-	Bushing, Polyamide	A689683-2	-	1
CR6001, CR6002	Diode, Silicon	A683966-1	-	2
CR6003, CR6004	Diode, Zener	A683971-1	-	2

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6001 through DS6010	Lamp, GE 327	-	AN3140-327	10
DS6011, DS6012	Not Used	-	-	10
DS6013 through DS6020	Lamp, GE 327	-	AN3140-327	8
DS6021, DS6022	Not Used	-	-	-
DS6023 through DS6036	Lamp, GE 327	-	AN3140-327	14
DS6037 through DS6040	Lamp, DIALCO No. 39	A683817-3	-	4
DS6041 through DS6046	Not Used	A683817-3	-	4
DS6047 through DS6058	Lamp, GE 327	-	AN3140-327	12
DS6059, DS6060	Lamp, DIALCO No. 39	A683817-3	-	2
K6001, K6002	Relay, Sensitive, 1000 ohm, 4.5 ma (DPDT)	A683968-1	-	2
K6003, K6004	Relay, 28 VDC, 6PDT	A683969-3	-	2

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
K6010, K6011	Relay, 115 VAC, 6PST	A696740-1	-	2
P6001 through P6010 P6013, P6014	Connector	-	MS3106R-14S-2S	12
P6015 through P6022	Connector	-	MS3106R-22-14S	8
S6001	Switch Assembly, consisting of:			
	Switch 4 PDT, (momentary)	A681845-3	-	1
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
	Lamps DS6007, DS6008	-	-	2
S6002	Switch Assembly, consisting of:			
	Switch 4PDT, (momentary)	A681845-3	-	1
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
	Lamps, DS6017, DS6018	-	-	2
S6003	Switch Assembly, consisting of:			
	Switch 4PDT, (momentary)	A681845-3	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1
	Color Filter (yellow)	A683911-2	-	2
	Lamps DS6027, DS6028	-	-	2
S6005	Switch Assembly, consisting of:			
	Switch 4PDT, (momentary)	A681845-3	-	1
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1
	Color, Filter (yellow)	A683911-2	-	2
	Lamps DS6047, DS6048	-	-	2
S6006	Switch Assembly, consisting of:			
	Switch 3PDT	A681845-4	-	1
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1
	Color, Filter (red)	A683911-1	-	2
	Color, Filter (green)	A683911-3	-	2
	Lamps DS6051, DS6052, DS6053, DS6054	-	-	4
S6007	Switch Assembly, consisting of:			
	Switch 3PDT	A681845-4	-	1
	Oper. Indicator Unit w/coil	A681843-3	-	1
	Display Screen	A681848-2	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Color, Filter (red)	A683911-1	-	2
	Color, Filter (green)	A683911-3	-	2
	Lamps DS6055, DS6056, DS6057, DS6058	-	-	4
T6001	Transformer	A665085-1	-	1
TB6001	Board, Terminal	L678298-8	-	1
TB6002 through TB6024	Board, Terminal	L678288-8	-	23
TB6027 through TB6030	Board, Terminal	L678288-8	-	4
X6001	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-2	-	1
	Color, Filter (yellow)	A683911-2	-	2
	Lamps DS6001, DS6002	-	-	2
X6002	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-4	-	1
	Color, Filter (red)	A683911-1	-	2
	Color, Filter (green)	A683911-3	-	2
	Lamps DS6003, DS6004, DS6005, DS6006	-	-	4
X6003	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-2	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE
P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Color, Filter (yellow)	A683911-2	-	2
	Lamps DS6009, DS6010	-	-	2
X6004	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-4	-	1
	Color Filter (red)	A683911-1	-	2
	Color Filter (green)	A683911-3	-	2
	Lamps DS6013, DS6014, DS6015, DS6016	-	-	4
X6005	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-2	-	1
	Color, Filter (yellow)	A683911-2	-	2
	Lamps DS6019, DS6020	-	-	2
X6006	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-4	-	1
	Color, Filter (red)	A683911-1	-	2
	Color, Filter (green)	A683911-3	-	2
	Lamps DS6023, DS6024, DS6025, DS6026	-	-	4
X6007	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-4	-	1
	Color Filter (red)	A683911-1	-	2
	Color Filter (green)	A683911-3	-	2
	Lamps DS6029, DS6030, DS6031, DS6032	-	-	4

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
X6008	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-4	-	1
	Color, Filter (red)	A683911-1	-	2
	Color, Filter (green)	A683911-3	-	2
	Lamps DS6033, DS6034, DS6035, DS6036	-	-	4
X6011	Indicator Unit:	A683961-2	-	1
	Display Screen	A681848-2	-	1
	Color, Filter (red)	A683911-1	-	2
	Lamps, DS6049, DS6050	-	-	2
XDS6037 through XDS6040, XDS6059, XDS6060	Pilot Light Assy.	A683815-1	-	6
XS6001 through XS6003, XS6005 through XS6007	Operator Indicator Unit w/coil	A681843-3	-	6
P6201	Connector	-	MS3106R-18-12S	1
P6202	Connector	-	MS3106R-20-7S	1
	Handwheel	C294673-1	-	2
	Intercom Panel	N654990-5	-	1

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE P/N 651465-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Synchro Line Amplifier, Milgo P/N 1007-10B	A683820-1	-	4
	Dual Power Supply	R651470-2	-	1
	Telephone Jack	A683777-1	-	10
	Barrier Strips (used with indicator units and switch assemblies)	A681860-2	-	27

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6201	Lamp, NE-51	C221315-1	-	1
F6201 through F6204	Fuse	C221603-502	-	4
FL6201	Filter, Dressen-Barnes Model 21-105	A681997-1	-	1
C6205	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6207	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6209	Capacitor, 50 WVDC, 4000 μf	-	-	1
L6201	Choke, Dressen-Barnes 512910	-	-	1
R6201	Resistor, ohmite, 600 ohm, 5W	-	-	1
FL6202	Filter, Dressen-Barnes Model 21-105	A681997-1	-	1
C6206	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6208	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6210	Capacitor, 50 WVDC, 4000 μf	-	-	1
L6202	Choke, Dressen-Barnes 512910	-	-	1
R6202	Resistor, Ohmite, 600 ohm, 5W	-	-	1
J6201	Receptacle, Box	-	MS3102R-18-12P	1
J6202	Receptacle, Box	-	MS3102R-20-7P	1
PS6201	Power Supply, Dressen-Barnes Model 21-103	A681999-3	-	1
C6201	Capacitor, 50 WVDC, 4000 μf	-	-	1
C6203	Capacitor, 50 WVDC, 4000 μf	-	-	1

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
CR6201	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6203	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6205	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6207	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
F6205	Fuse, 10 amp.	-	-	1
T6201	Transformer, Dressen-Barnes 511721	-	-	1
PS6202	Power Supply, Dressen-Barnes Model 21-103	A681999-3	-	1
C6202	Capacitor, 50 WVDC 4000 μf	-	-	1
C6204	Capacitor, 50 WVDC 4000 μf	-	-	1
CR6202	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6204	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6206	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
CR6208	Diode, 1N2129, International Rectifier Type X25HB10	-	-	1
F6206	Fuse, 10 amp.	-	-	1
T6202	Transformer, Dressen-Barnes 511721	-	-	1
XDS6201	Light, Indicator	C221313-7	-	1

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2
(Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
XF6201 through XF6204	Post, Fuse, 3 AG	A683967-1	-	4

TABLE 6-III. LIST OF REPLACEABLE ELECTRICAL PARTS FOR INTERCOM PANEL, P/N N654990-5

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
D6401	Dial, Telephone, WECO P/N 6L-41	A683776-1	-	1
DS6401	Buzzer, WECO P/N 7F-42	A683505-1	-	1
R6401	Dual Potentiometer, WECO P/N KS13754	A683378-1	-	1
Z6401 through Z6404	Key	A683775-1	-	4
	Knob	C294634-1	-	1
	ASSOCIATED PARTS			
	Connector and Cable Assy.	A683543-1	-	4
	Connector	A683542-1	-	1

TABLE 6-IV. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACTIVE ACQUISITION AID CONTROL CONSOLE SIGNAL STRENGTH METER PANEL, P/N L654992-1

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS1 through DS4	Lamp, DIALCO No. 39	A683817-3	-	4
M1 through M4	Microammeter, 0-50 μ amps	N683770-1	-	4
R1 through R4	Potentiometer, 500K	C219564-6	-	4
R5 through R8	Resistor, fixed, 240K, 5%, 1/4W	-	RC07GF244J	4
XDS1 through XDS4	Pilot Light Assy.	A683815-1	-	4

TABLE 6-V. LIST OF REPLACEABLE ELECTRICAL PARTS FOR MISCELLANEOUS ITEMS

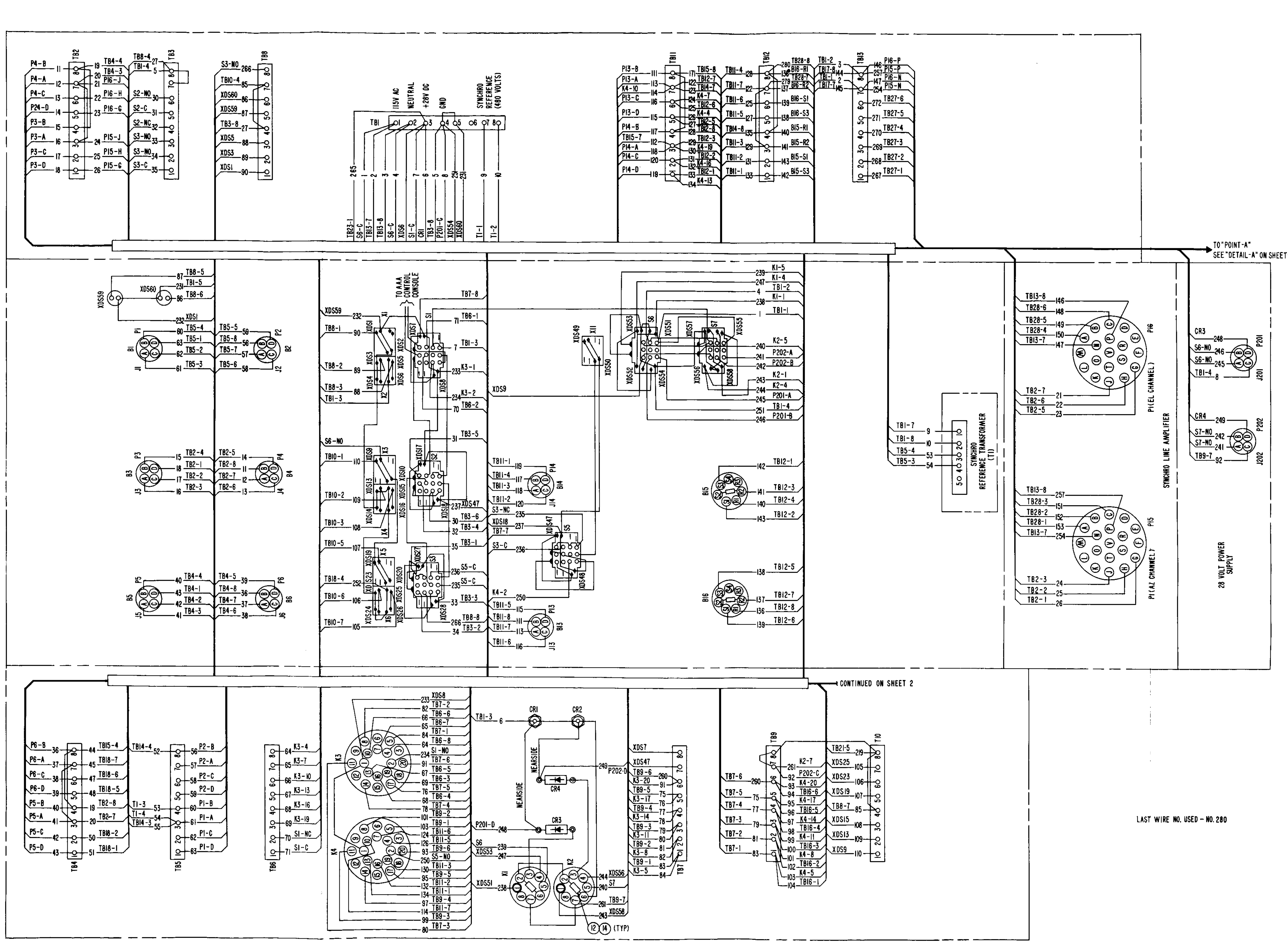
Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Transformer, Step-up, 115 VAC pri; 480 VAC sec.	A665084-1	-	1
	Transformer, Step-down, 480 VAC pri; 115 VAC sec.	A665085-1	-	5
	Cutoff Switch and Warning Light Assembly, consisting of:	L653858-1	-	1
	Switch and box, ERTA 12022	A683229-1	-	1
	Warning light assy.	A683135-1	-	1
	Lamp, Incandescent	A120680-1	-	1
	Cable	689846-2	-	-
	Panel, Master-Slave Relay	653770-1	-	1
	Terminal board	L678288-12	-	2
	Relay, 28 VDC, 6PDT	A683969-3	-	1

Note: For FPS-16 radar control relay, refer to parts list for data switch unit in Radar Tracking System Manual, MS-101.

SECTION VII
MAINTENANCE DRAWINGS

7-1. GENERAL

The drawings included in this section are listed below. It should be noted that those schematics which show connections or circuits involving two or more separate pieces of equipment are not in all cases complete in regard to the internal circuits of the equipment. For complete internal circuits, see the schematics of the individual pieces of equipment. The schematics of individual pieces of equipment are included in this section or in the individual equipment manuals, listed in table 1-II.



NOTES:

1. ADD 6000 TO REFERENCE DESIGNATIONS IN THIS UNIT EXCEPT SYNCHRO REFERENCE TRANSFORMER.
2. SYNCHRO REFERENCE TRANSFORMER LOCATED IN CENTER OF BACK OF CONSOLE.
3. ALL WIRES BREAKING OUT OF CABLES TO BE ONE INCH LONGER THAN NECESSARY WITH EXCESS WIRE DRESSED IN A NEAT LOOP ADJACENT TO TERMINALS.
4. UNLESS OTHERWISE SPECIFIED ALL WIRES ARE WHITE AND ARE NO. 18
5. SECTION REFERENCE DESIGNATIONS OF SWITCHES ARE AS FOLLOWS

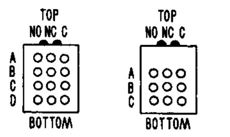


Figure 7-2. Acquisition Data Console, Physical Wiring Diagram (Sheet 1 of 2)

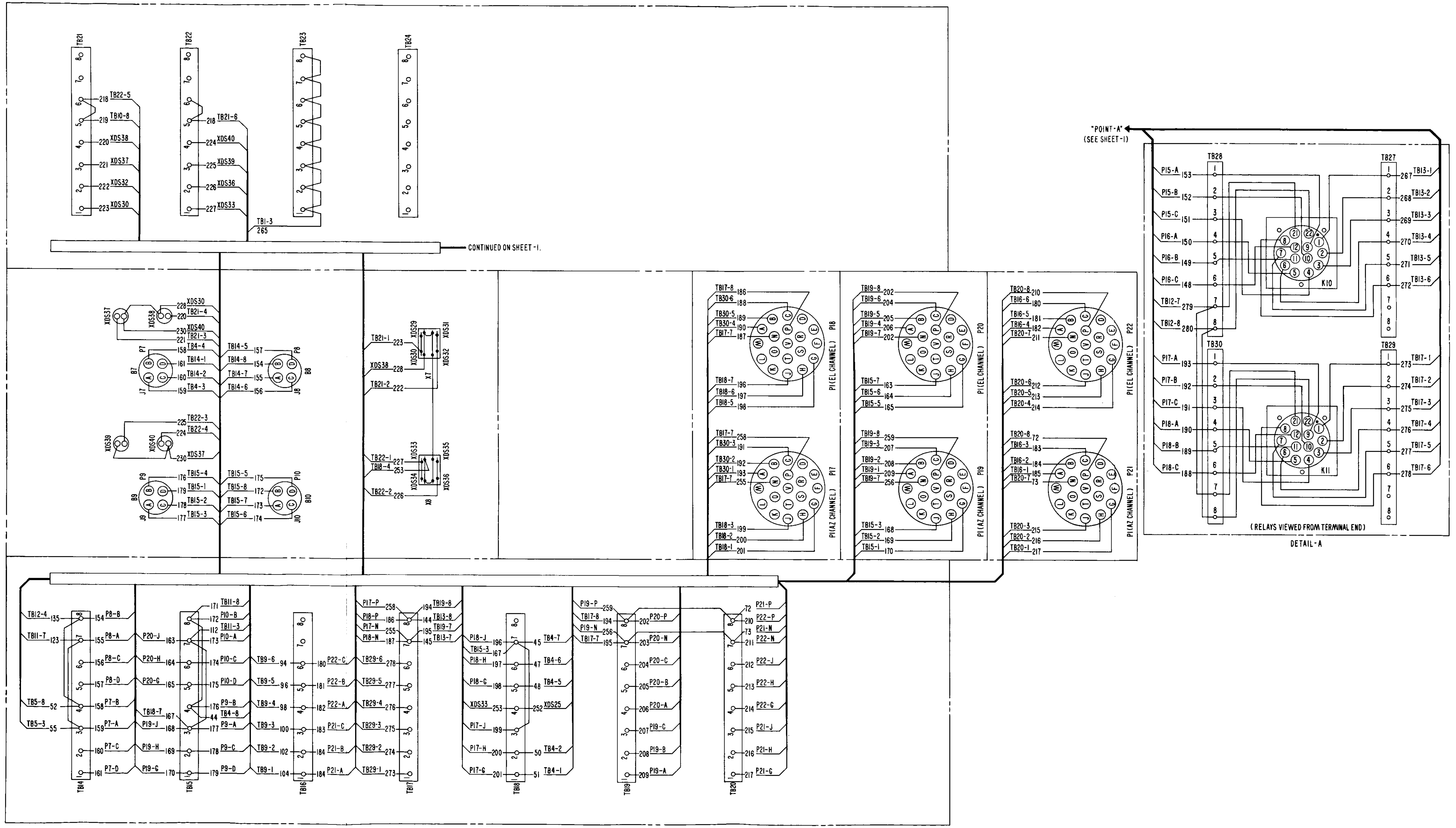
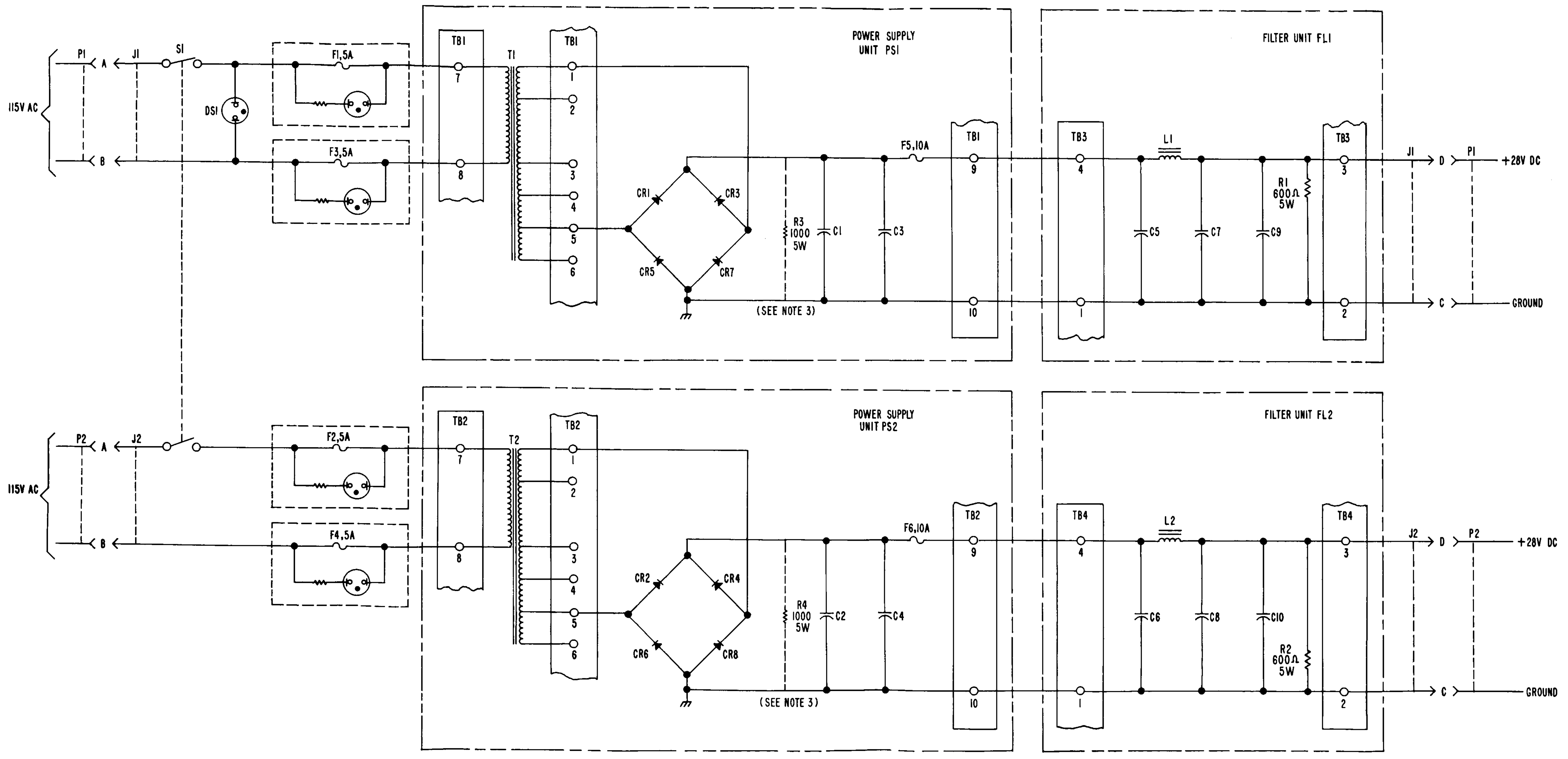
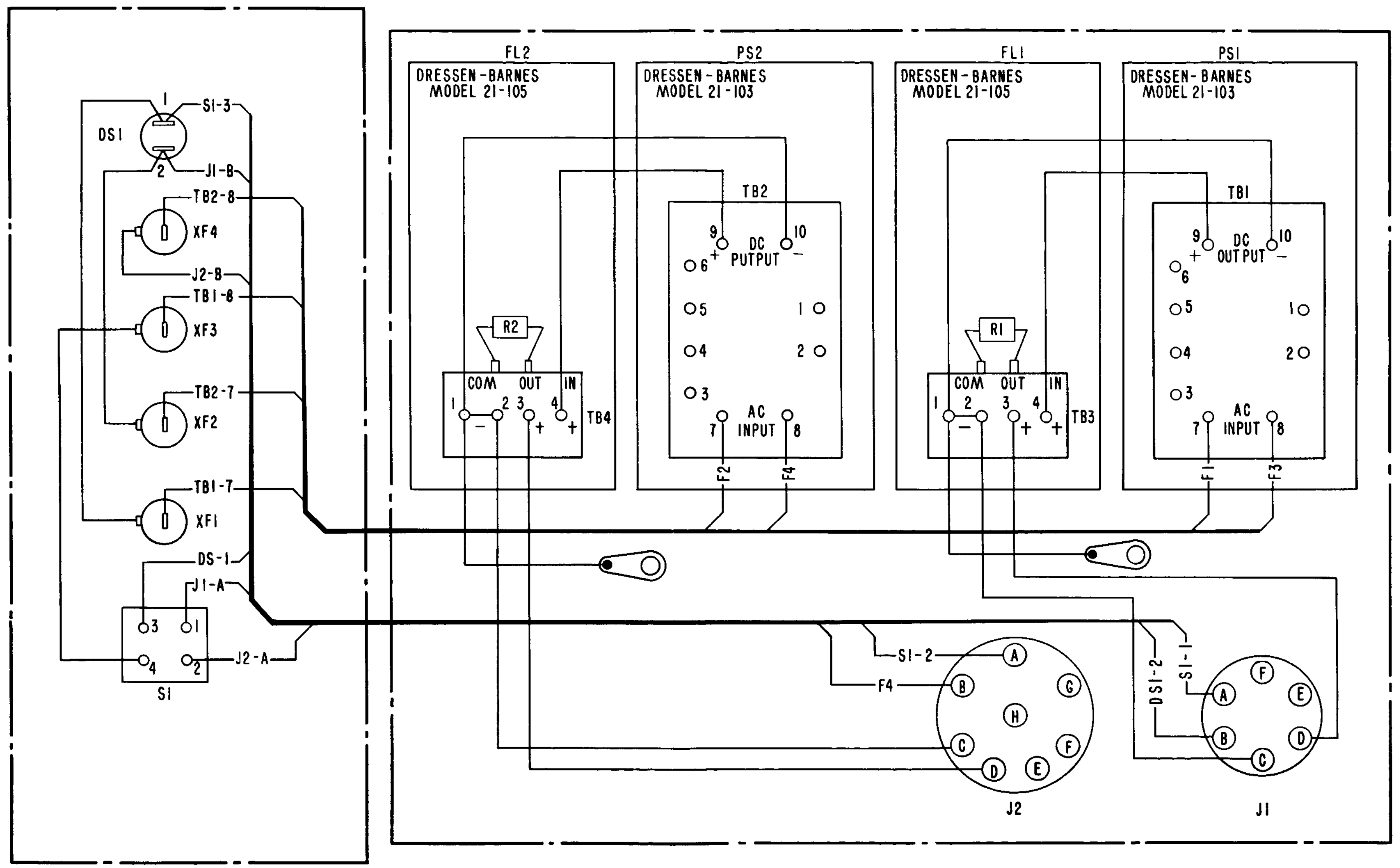


Figure 7-2. Acquisition Data Console, Physical Wiring Diagram (Sheet 2 of 2)



NOTES:
1. ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.
2. ALL CAPACITORS ARE 4000 UF 50VDC.
3. BLEEDER RESISTORS R3 AND R4 NOT USED ON SOME MODELS.

Figure 7-3. Dual Power Supply, Schematic Diagram



NOTE:
ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.

Figure 7-4. Dual Power Supply, Physical Wiring Diagram

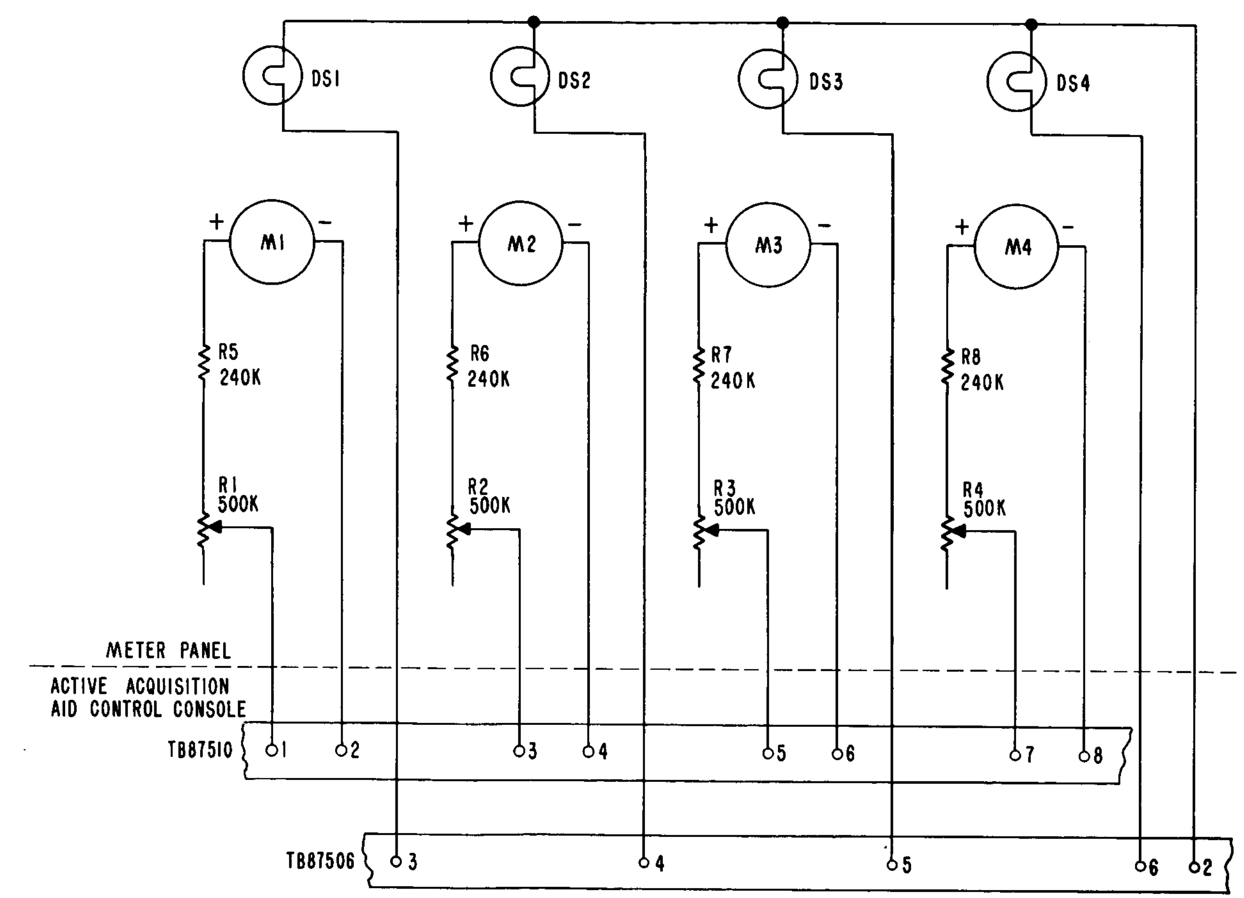


Figure 7-5. Active Acquisition Aid Control Console Signal Strength Meter Panel, Schematic Diagram

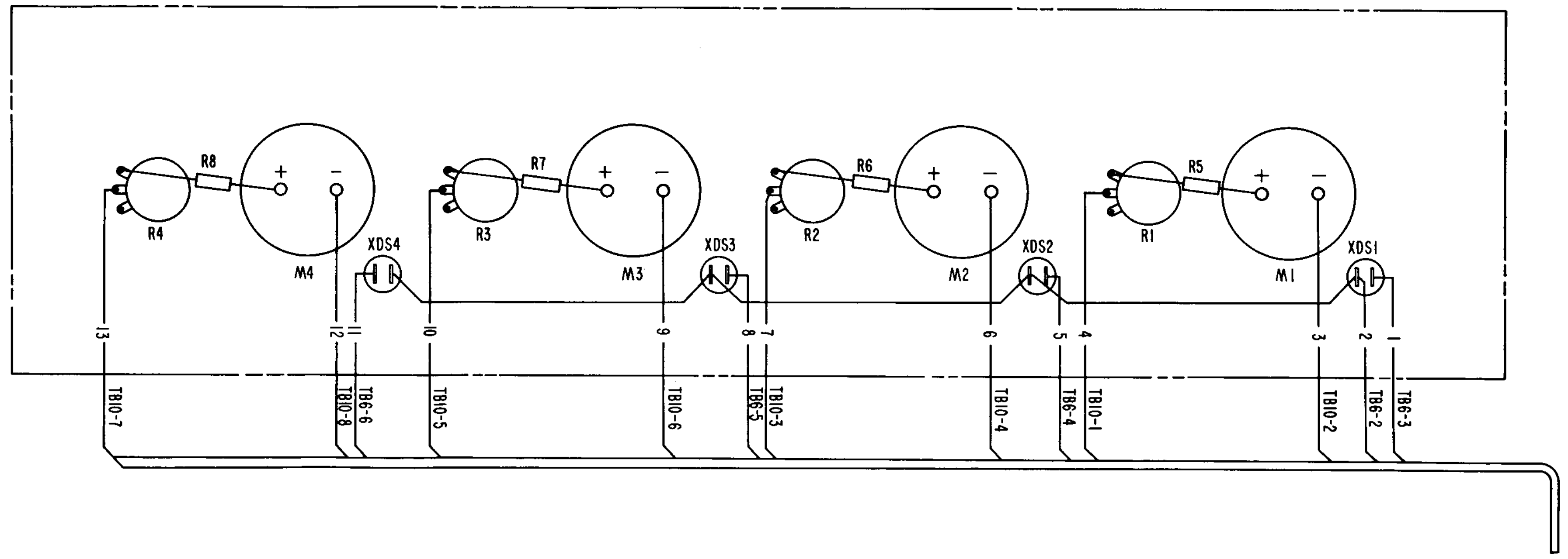


Figure 7-6. Active Acquisition Aid Control Console Signal Strength Meter Panel, Physical Wiring Diagram

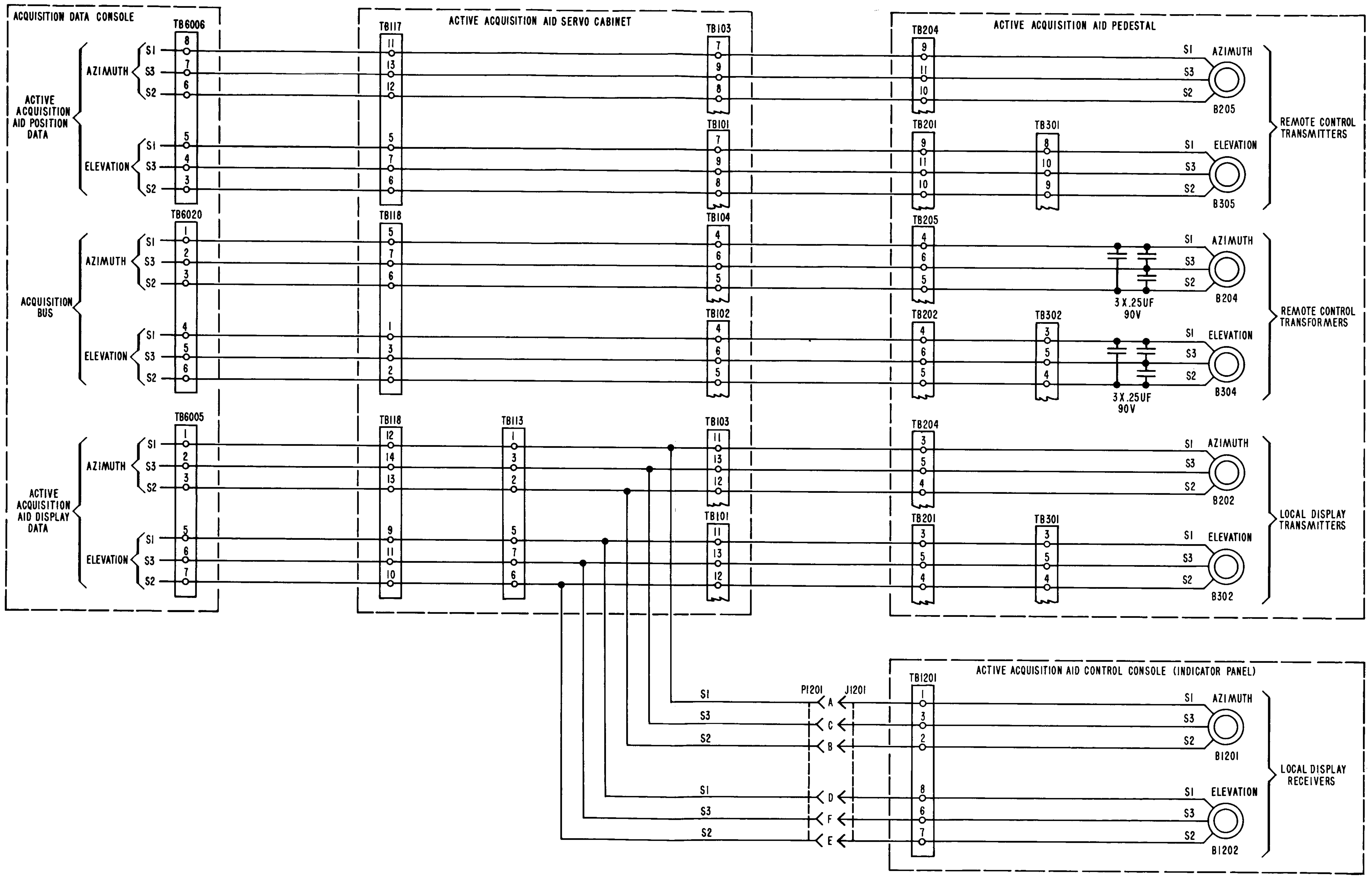


Figure 7-7. Synchro Stator Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram

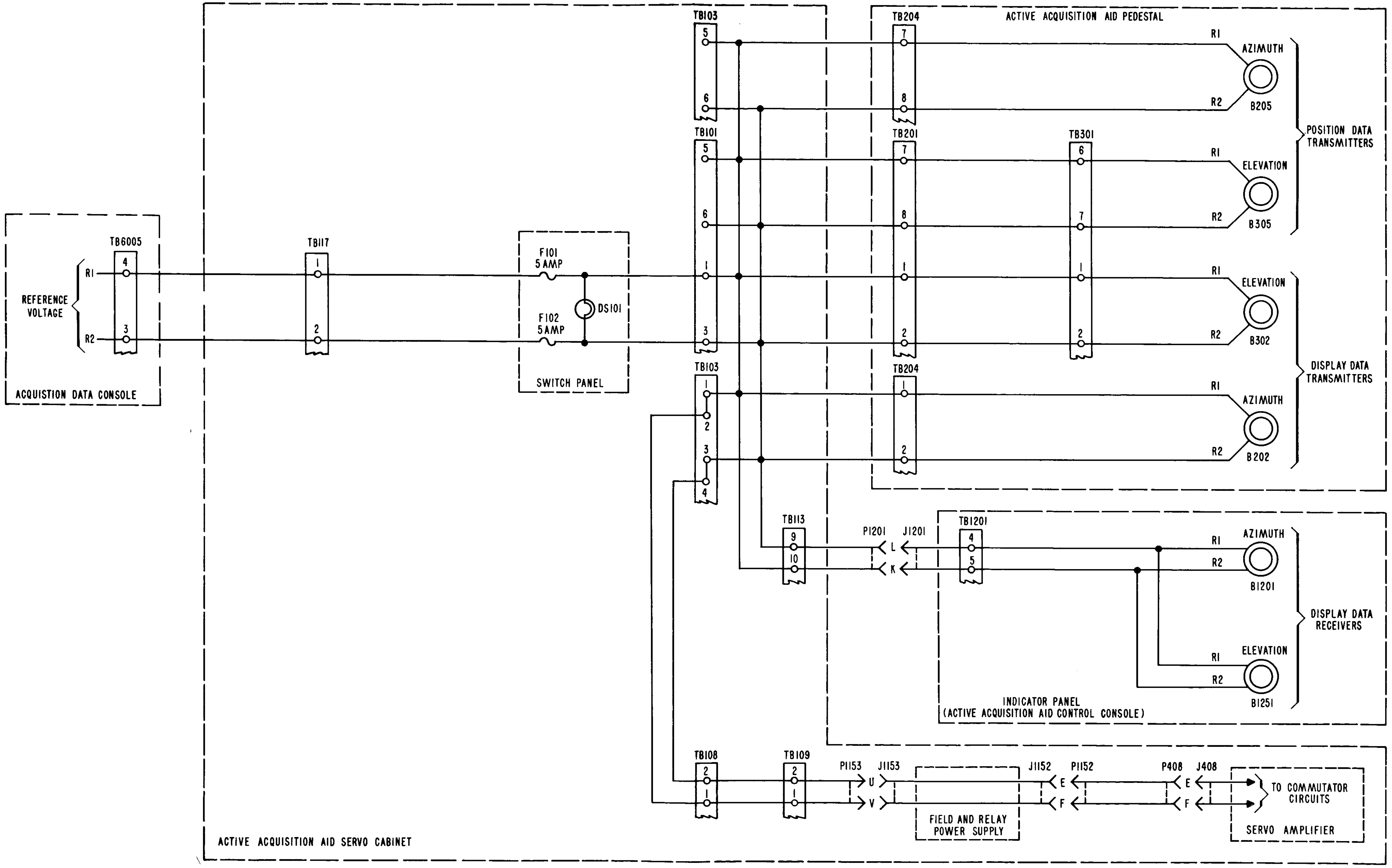


Figure 7-8. Synchro Reference Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram

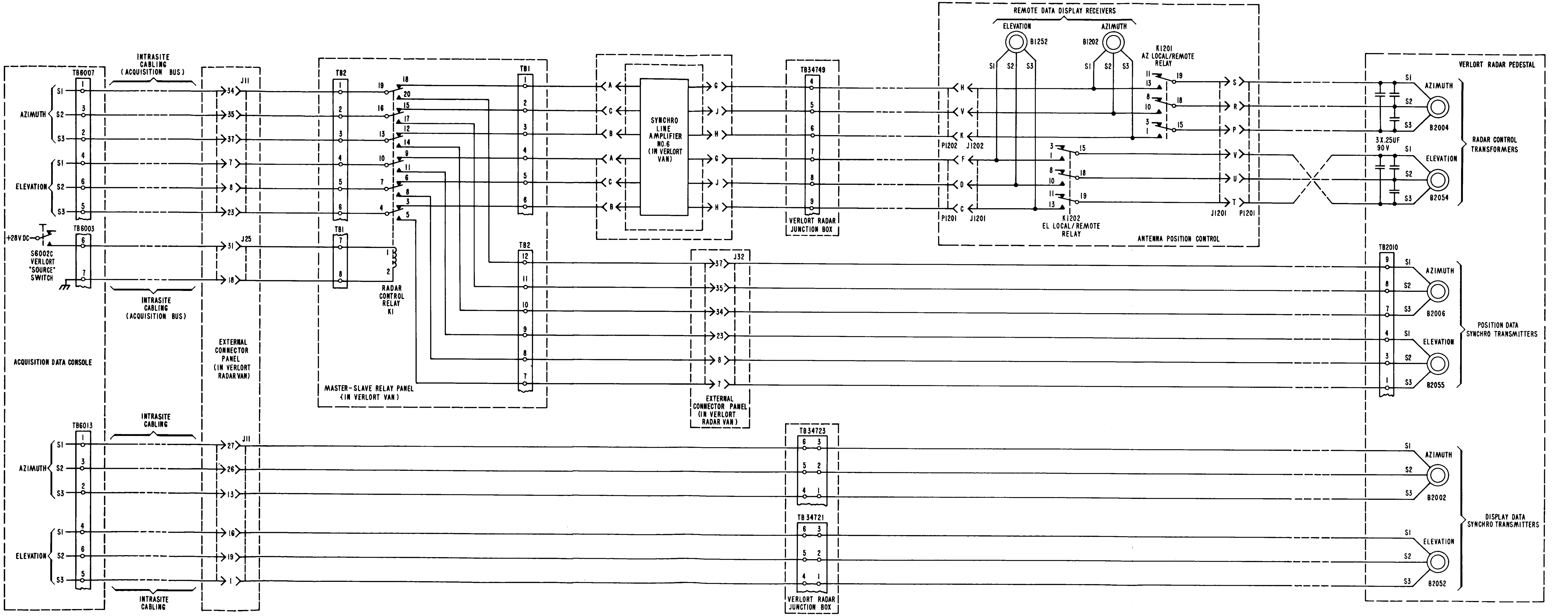


Figure 7-9. Synchro Stator Circuit Connections between Verlort Radar and Acquisition Data Console, Schematic Diagram

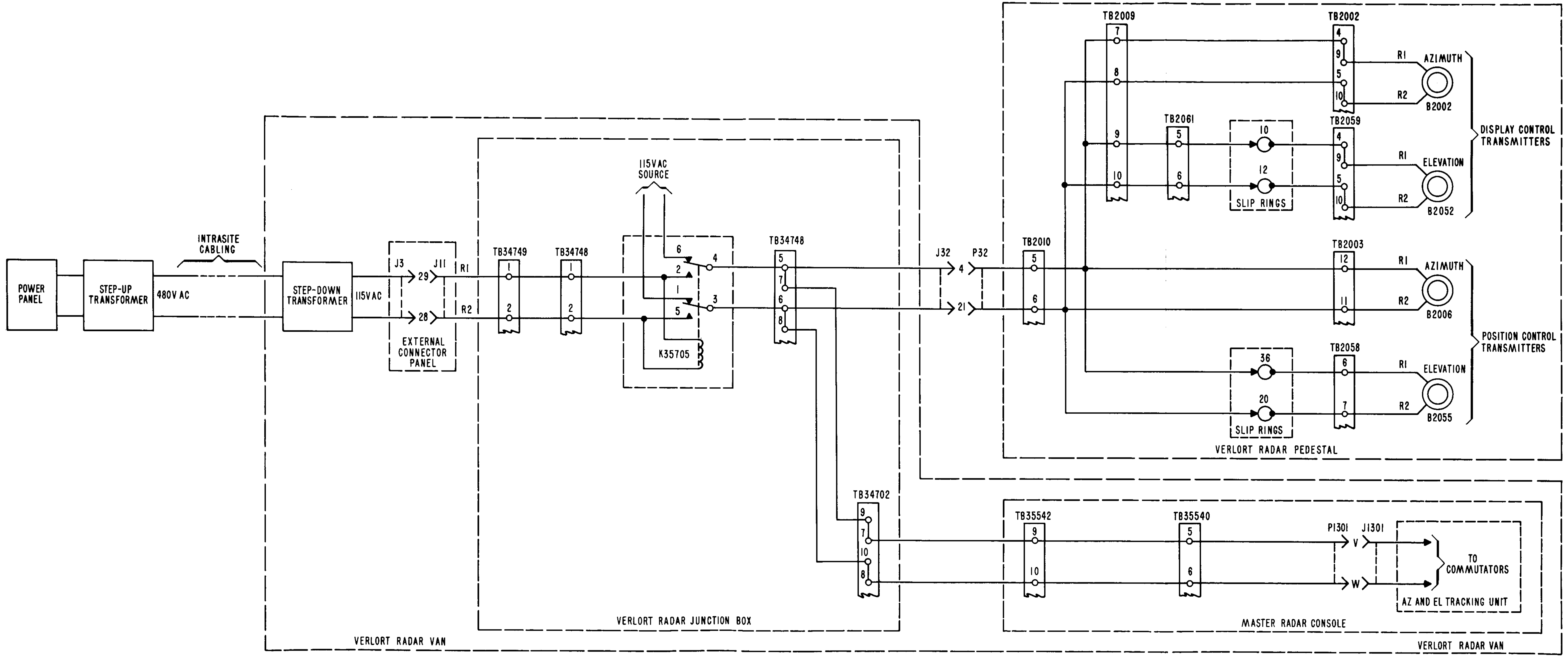
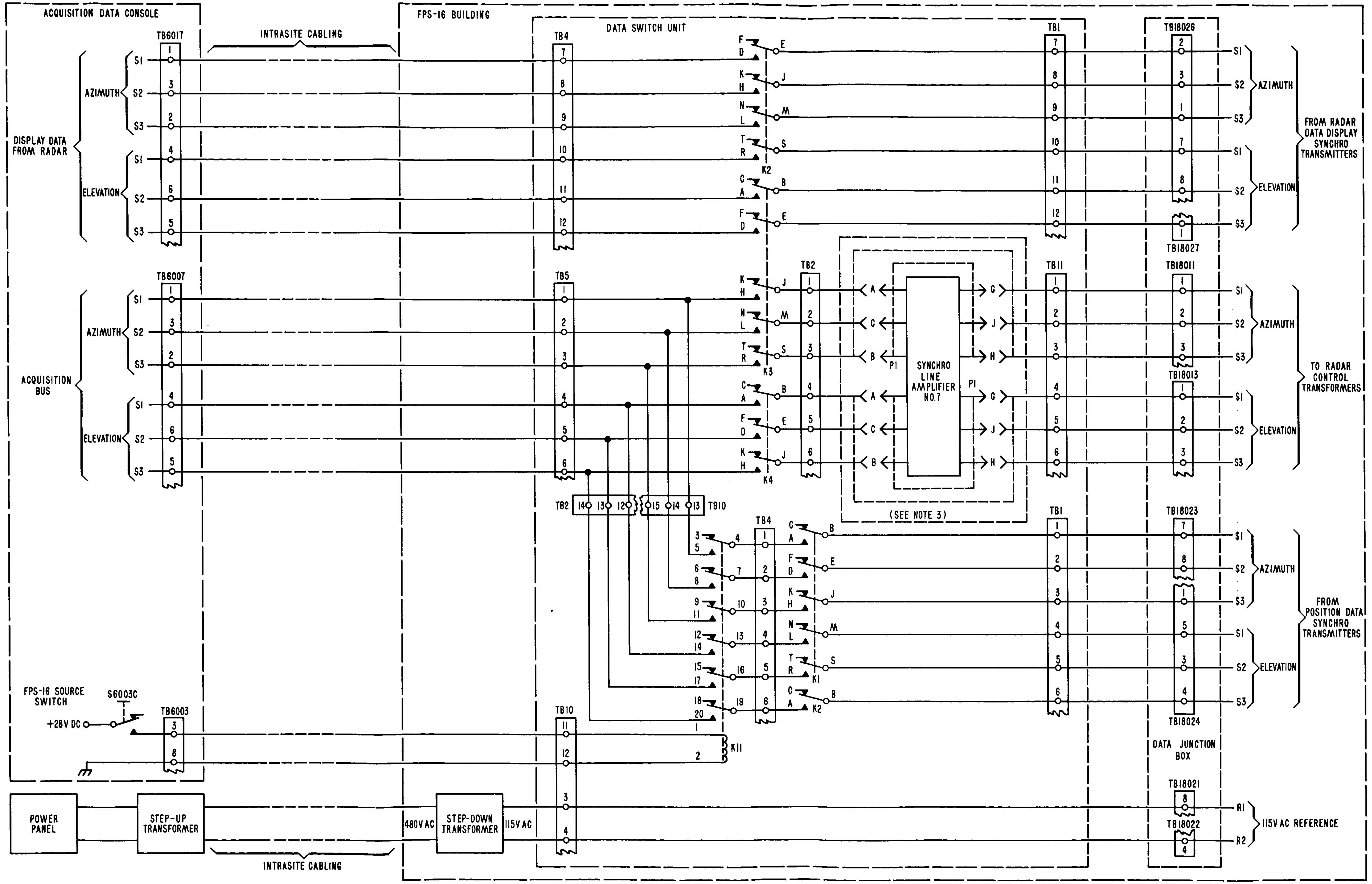


Figure 7-10. Synchro Reference Circuit Connections between Verlort Radar and Site Power Panel, Schematic Diagram



NOTES—

1. RELAYS K1 THROUGH K4 ARE ENERGIZED BY 115VAC FROM RADAR DATA TRANSFER SWITCH. THESE RELAYS ARE ENERGIZED AT ALL TIMES DURING A MERCURY PASS.
2. RELAY K11 IS SHOWN UNENERGIZED. ALL OTHERS ARE SHOWN ENERGIZED.
3. SYNCHRO LINE AMPLIFIER IS NOT PART OF DATA SWITCH UNIT.

Figure 7-11. Synchro Circuit Connections between FPS-16 Radar and Acquisition Data Console, Schematic Diagram

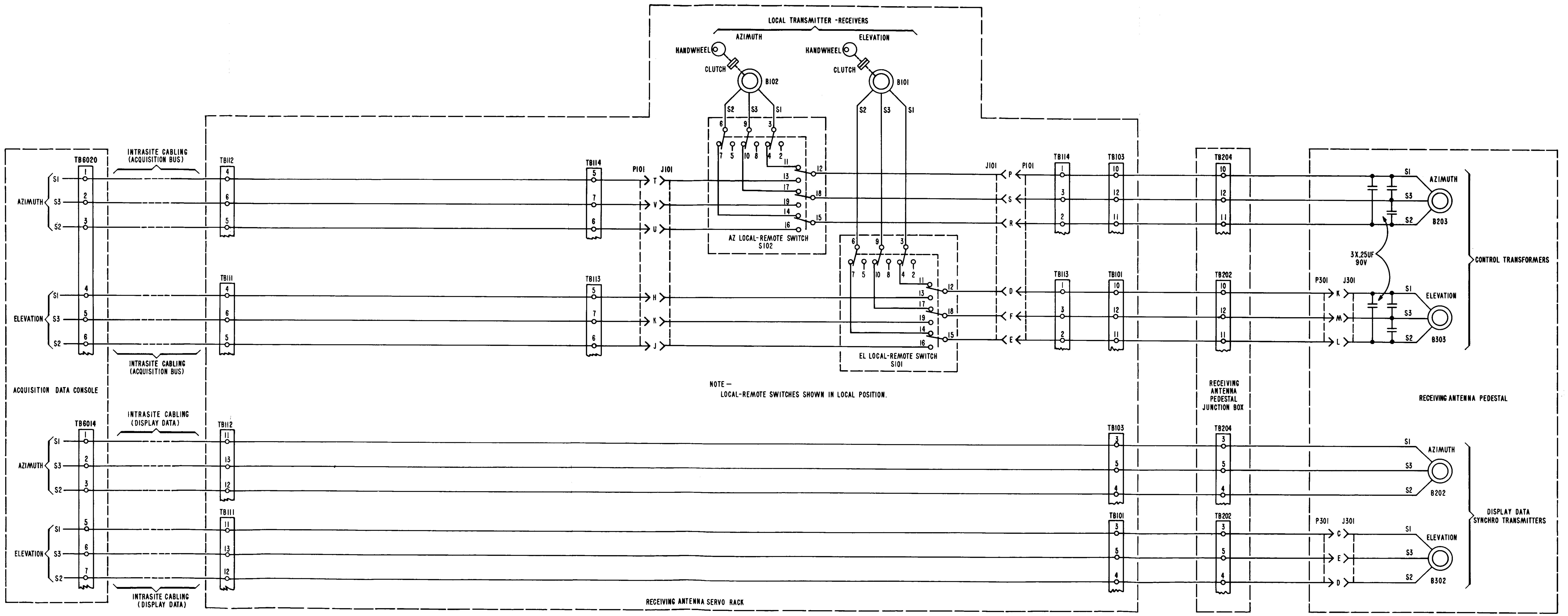


Figure 7-12. Synchro Stator Circuit Connections between Receiving Antenna and Acquisition Data Console, Schematic Diagram

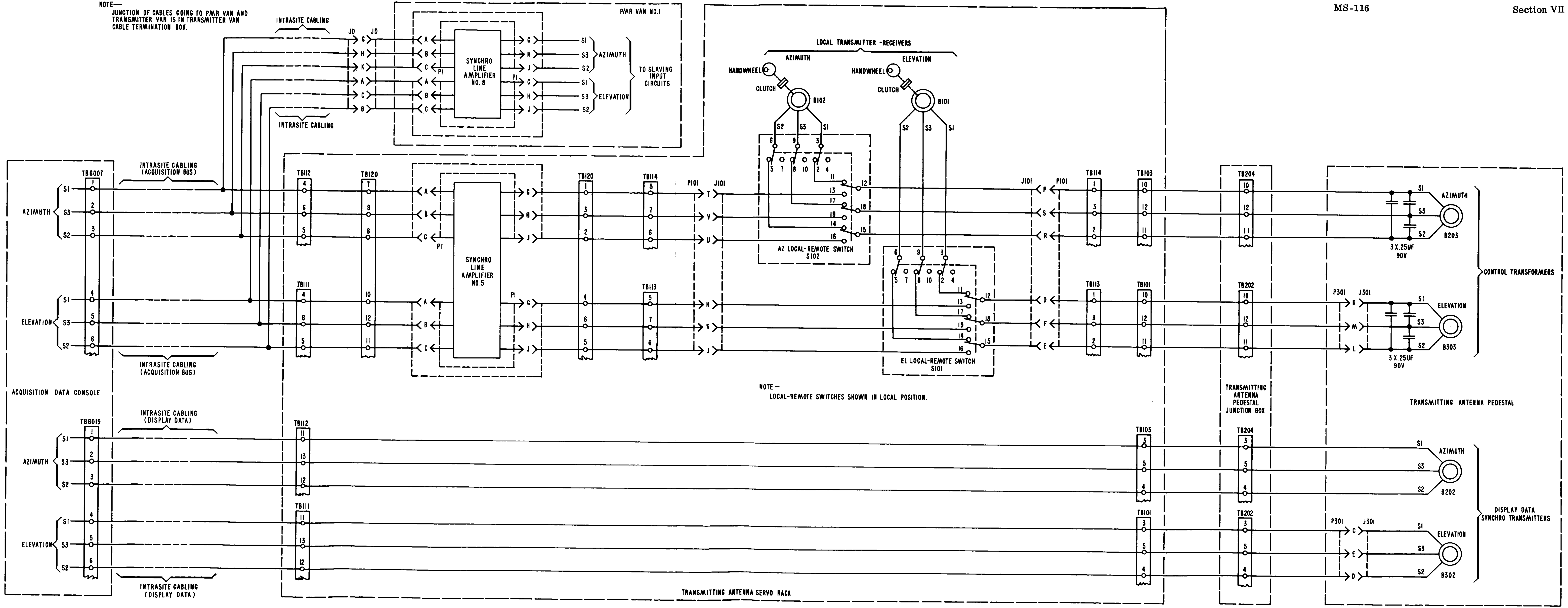


Figure 7-13. Synchro Stator Circuit Connections between Transmitting Antenna, PMR Van, and Acquisition Data Console, Schematic Diagram

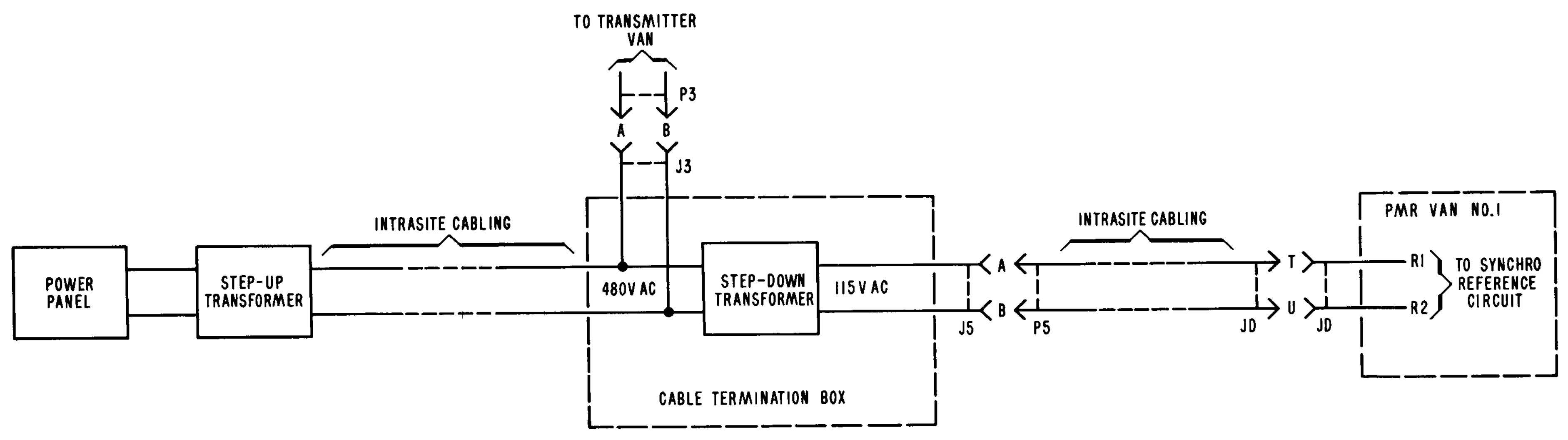


Figure 7-14. Synchro Reference Circuit Connections between PMR Van and Site Power Panel, Schematic Diagram

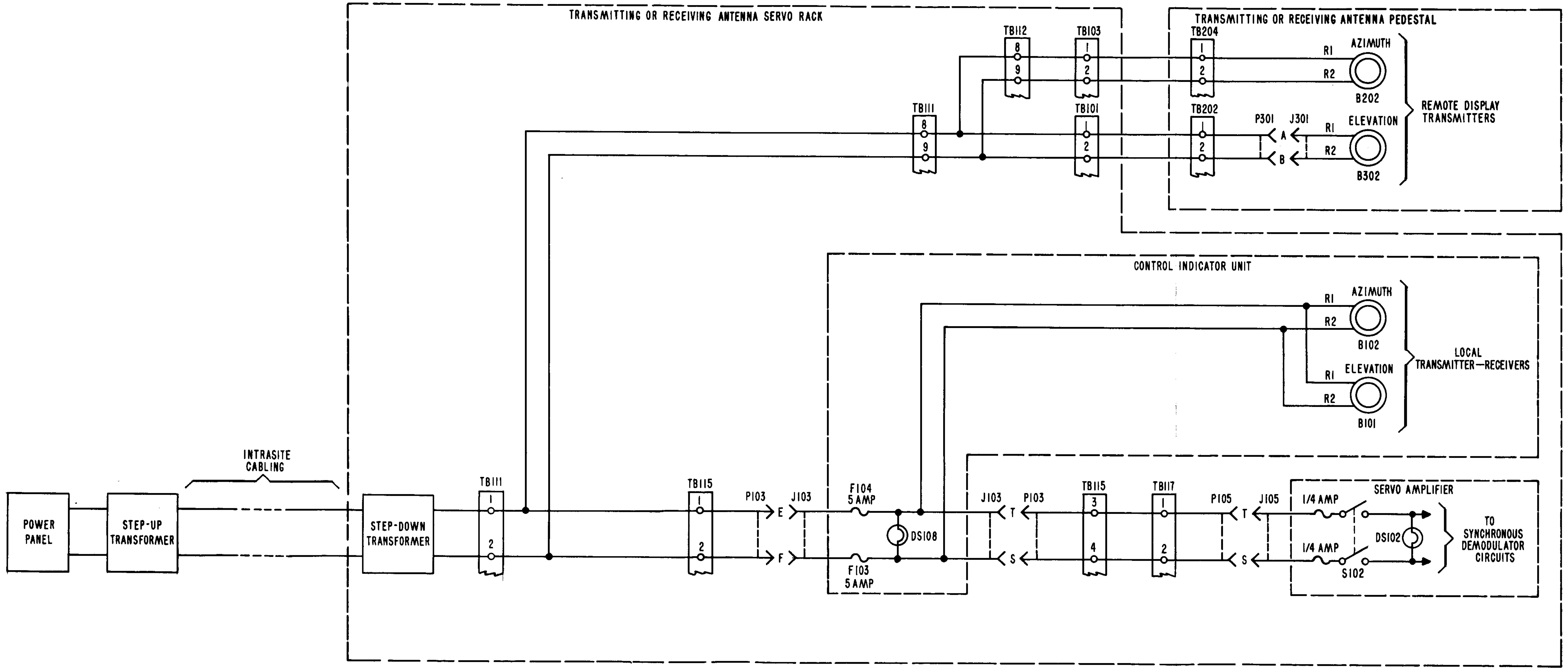
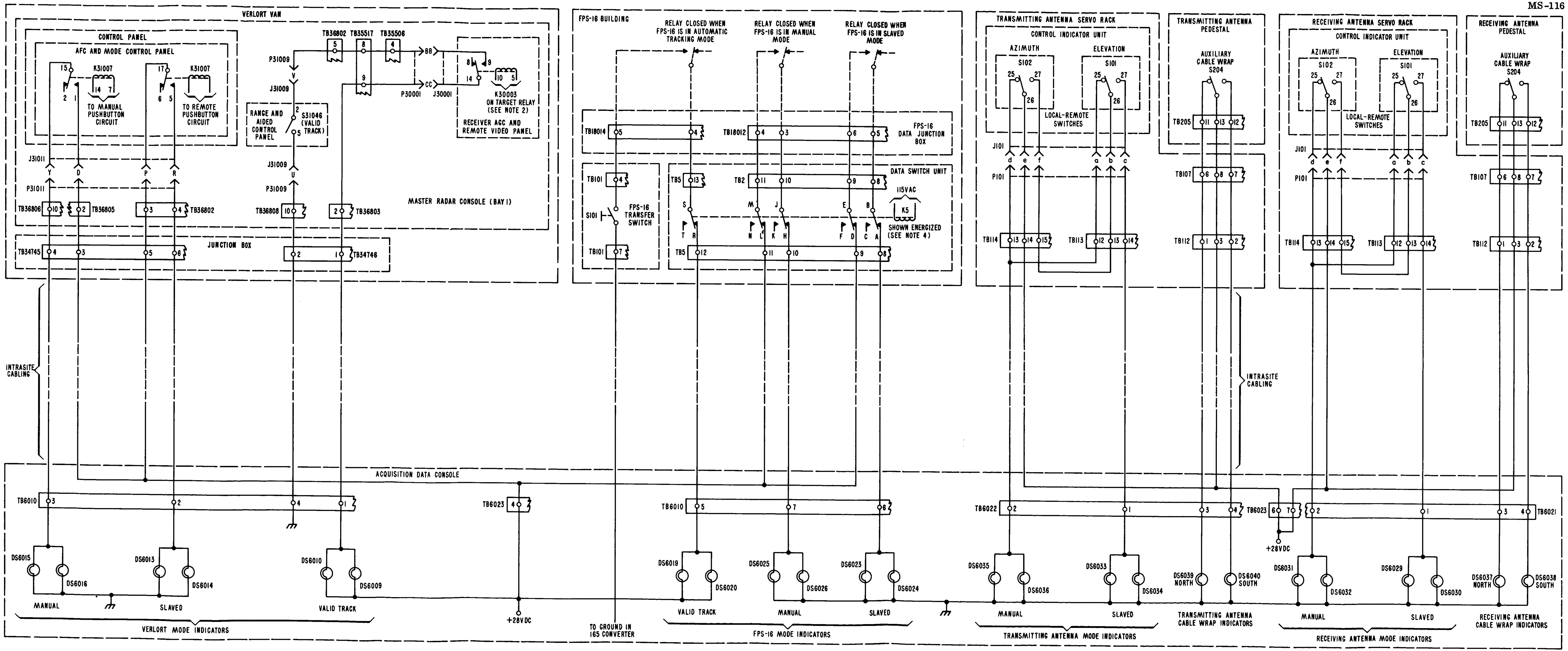


Figure 7-15. Synchro Reference Circuit Connections between Receiving or Transmitting Antenna and Site Power Panel, Schematic Diagram



NOTES—

1. LOCAL-REMOTE SWITCHES OF ALL ANTENNAS SHOWN IN MANUAL POSITION.
2. ON TARGET RELAY ENERGIZED BY OPERATION OF RANGE-GATE CIRCUIT.
3. LOCAL CABLE WRAP INDICATORS ON TRANSMITTING AND RECEIVING ANTENNA SERVO RACK ARE OPERATED FROM 6.3VAC BY SWITCH S203. THE LOCAL INDICATOR CIRCUIT IS INDEPENDENT OF THAT SHOWN ON THIS DRAWING. REFER TO EQUIPMENT MANUAL.
4. RELAY K5 IS ENERGIZED AT ALL TIMES DURING MERCURY EVENT.

Figure 7-16. D-c Indication Circuits from External Equipment (except AAA) to Acquisition Data Console, Schematic Diagram

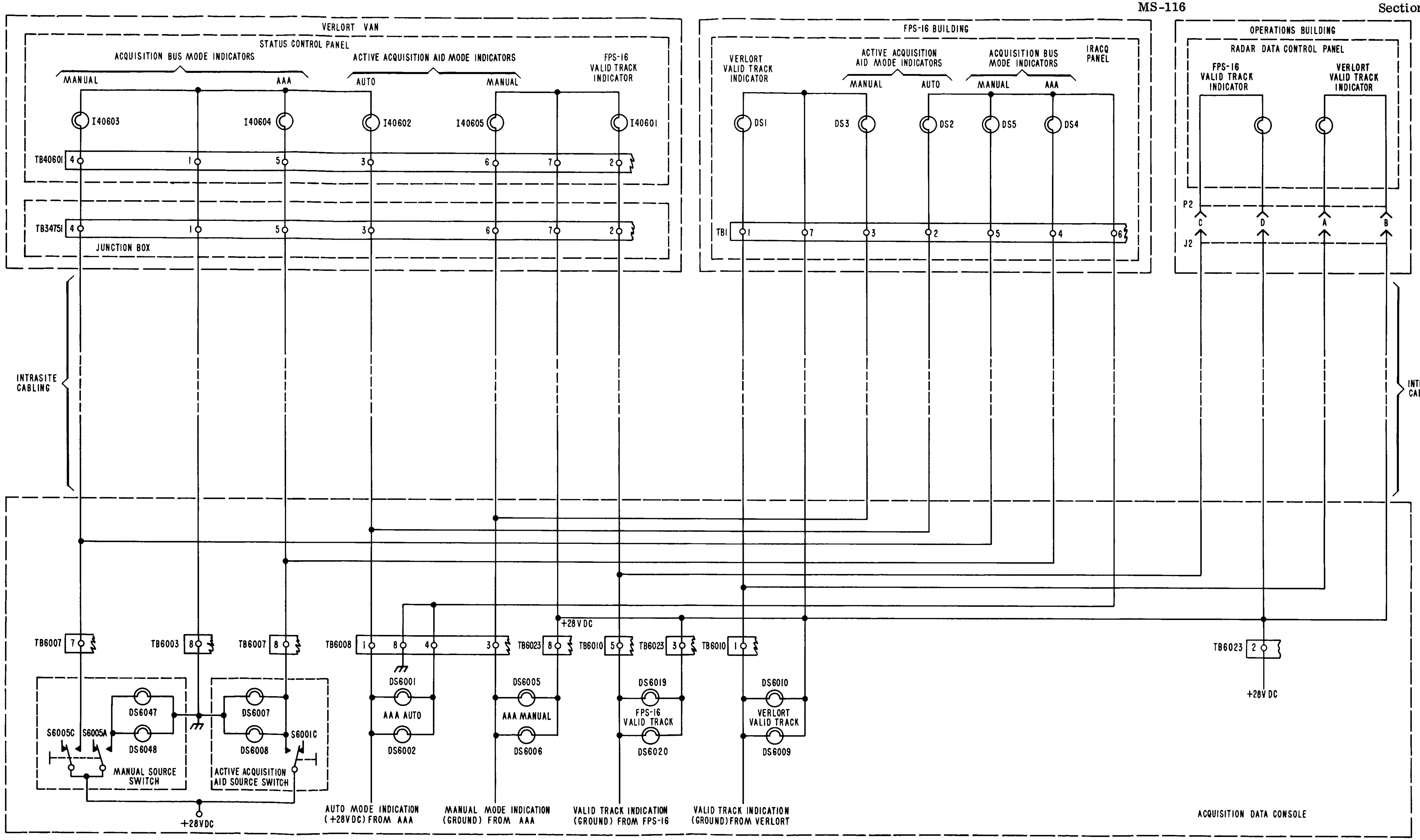


Figure 7-17. D-c Indication Circuits from Acquisition Data Console to External Equipment, Schematic Diagram

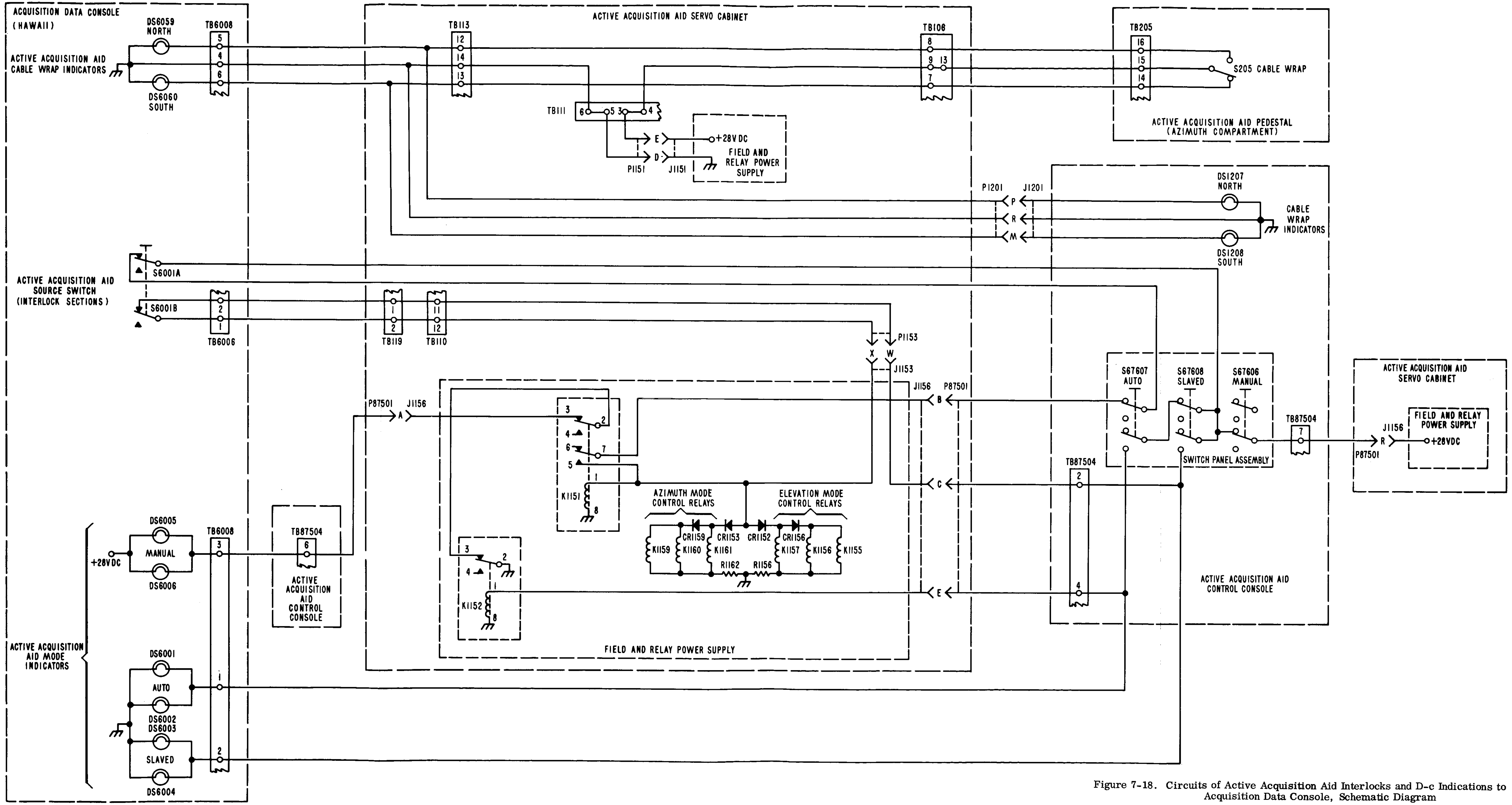
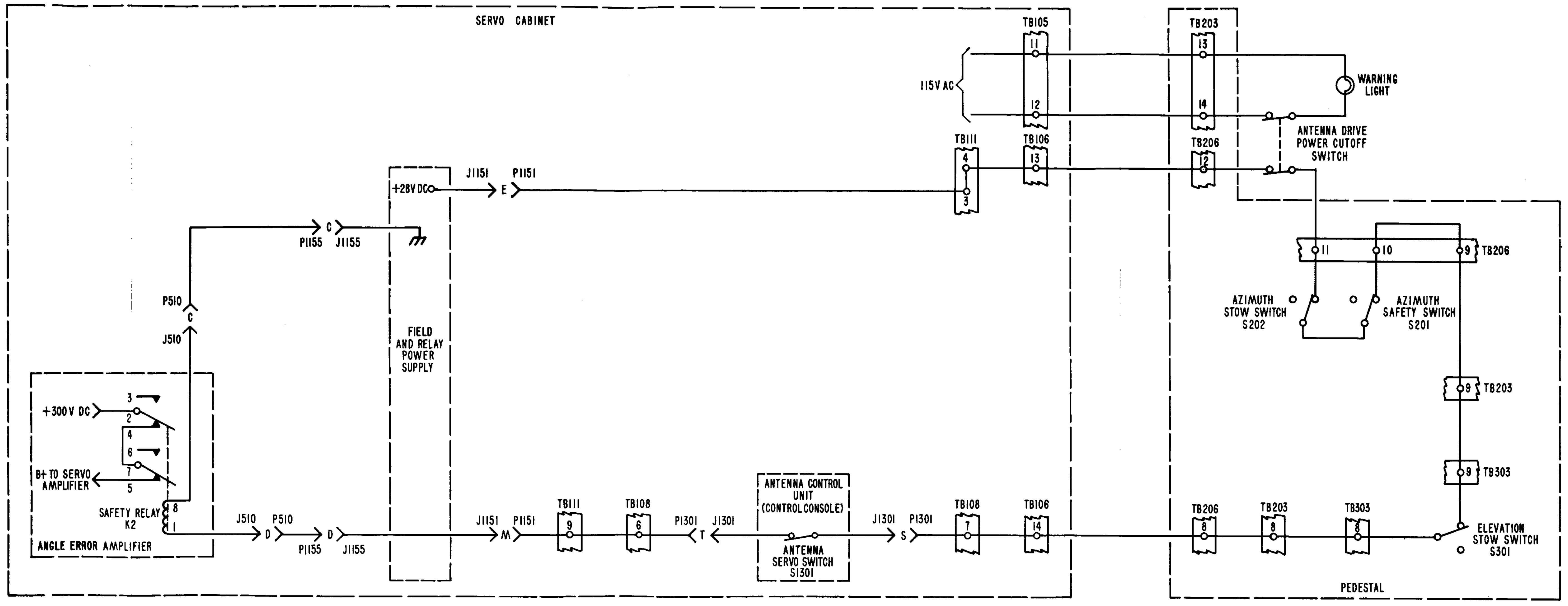


Figure 7-18. Circuits of Active Acquisition Aid Interlocks and D-c Indications to Acquisition Data Console, Schematic Diagram



NOTES—
1. ALL SWITCHES SHOWN IN RUN (OPERATING) POSITION.
2. RELAY SHOWN IN ENERGIZED POSITION.
3. ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (ONE ASSEMBLY) ARE MOUNTED NEAR TOP OF LADDER LEADING TO ANTENNA PLATFORM.

Figure 7-19. Active Acquisition Aid Antenna Safety Circuit, Schematic Diagram

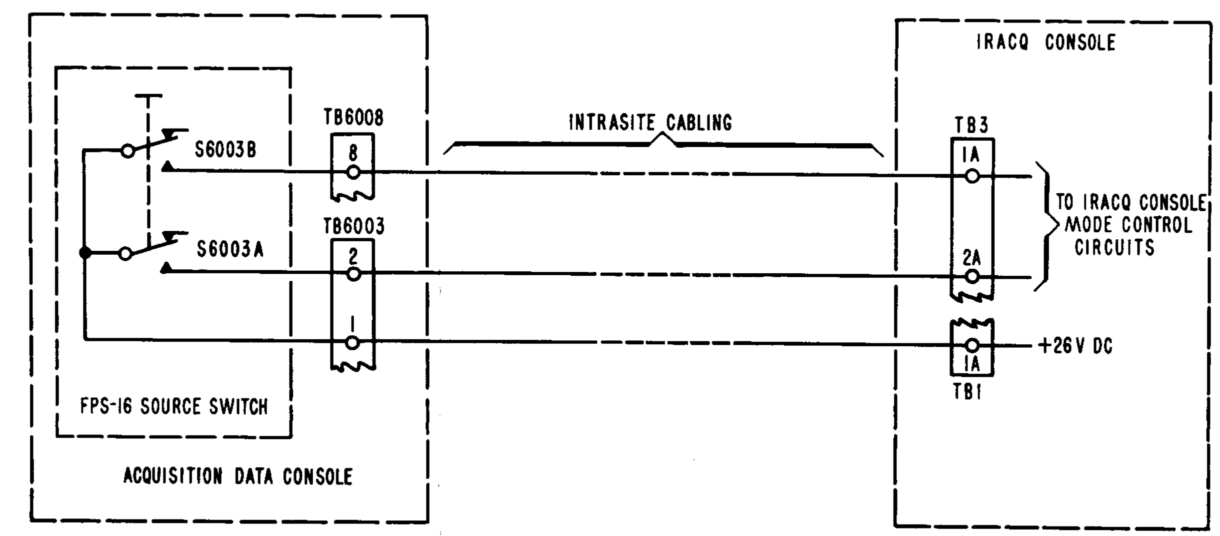


Figure 7-20. FPS-16 Slaving Interlock Circuit, Schematic Diagram

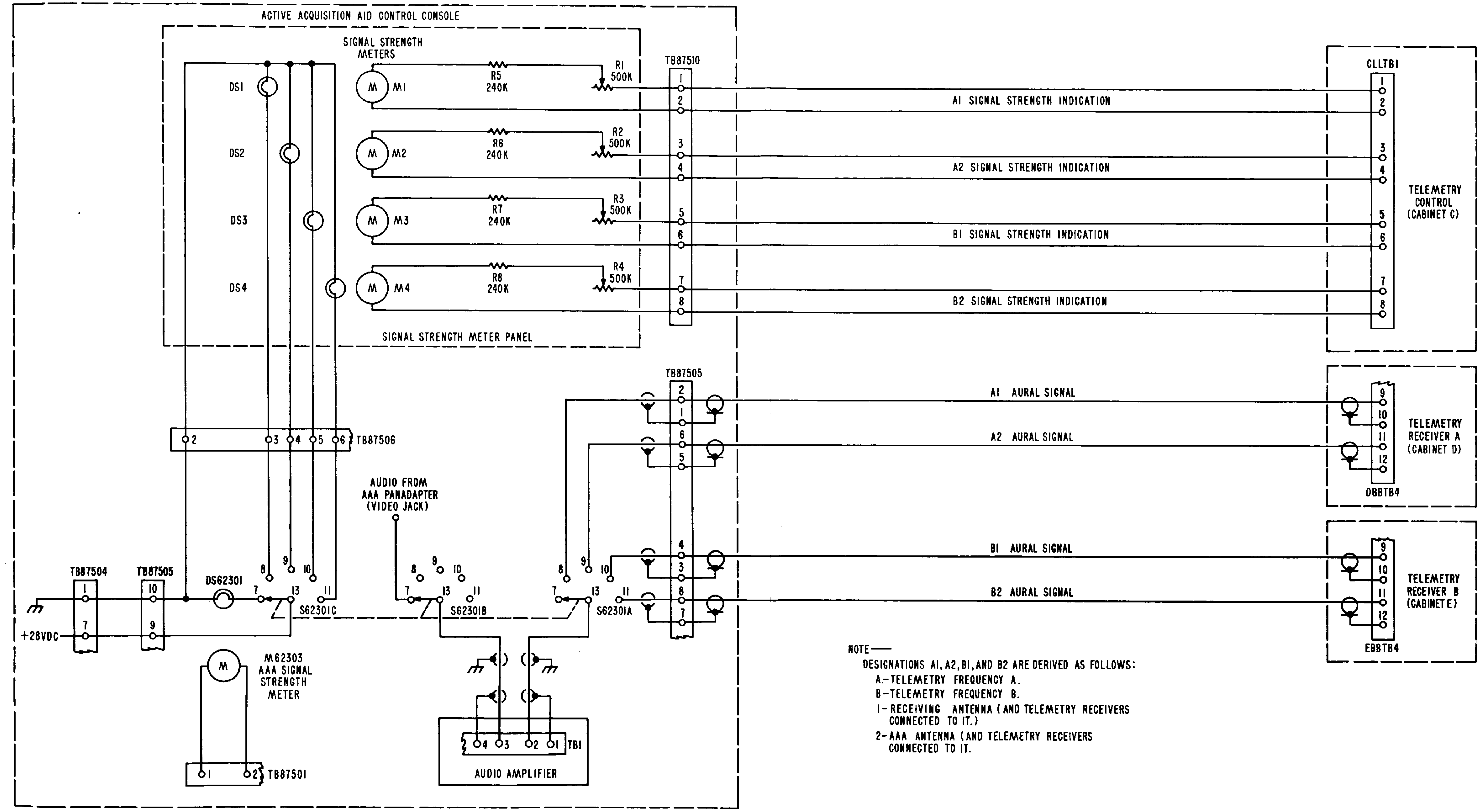


Figure 7-21. Signal Strength Indication and Audio Monitor Circuits, Schematic Diagram

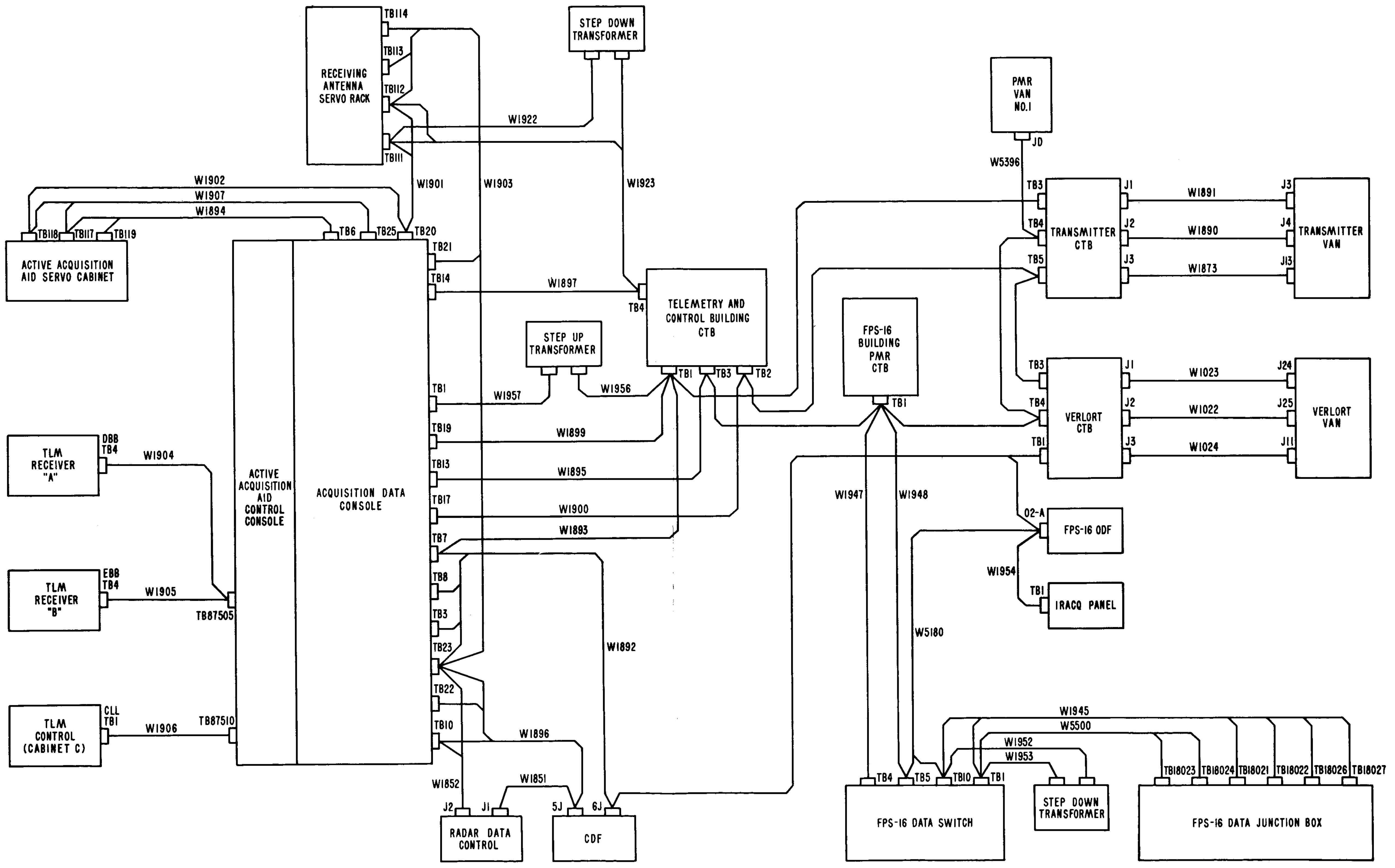


Figure 7-22. Acquisition System Interconnecting Cabling Diagram

SPACE CRAFT, INC.

Space Craft, Inc.
8620 South Memorial Parkway
Huntsville, Alabama